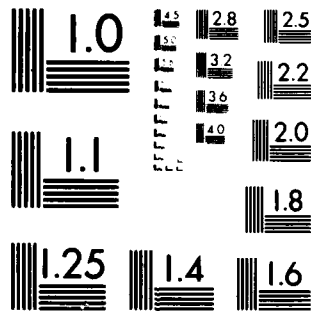MICROCOPY RESOLUTION TEST CHART
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FINAL REPORT PR 82-3-329

Training Requirements and Cost Evaluation System (TRACES) for Marine Air Command and Control: Phase II

John F. Patterson
Leonard Adelman

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TRAINING REQUIREMENTS AND COST EVALUATION SYSTEM (TRACES) FOR MARINE AIR COMMAND AND CONTROL: PHASE II

by

John F. Patterson and Leonard Adelman

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER PR 82-3-329	2. 3OVT ACCESSION NO. AD-A114 819	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) TRAINING REQUIREMENTS AND COST EVALUATION SYSTEM (TRACES) FOR MARINE AIR COMMAND AND CONTROL: PHASE II		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) John F. Patterson Leonard Adelman		8. CONTRACT OR GRANT NUMBER(s) M00027-81-C-0052
9. PERFORMING ORGANIZATION NAME AND ADDRESS Decisions and Designs, Inc. Suite 600, 8400 Westpark Dr., P.O. Box 907 McLean, VA 22101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Commandant of the Marine Corps Headquarters, U.S. Marine Corps (Code LBC) Washington, DC 20380		12. REPORT DATE May 1982
		13. NUMBER OF PAGES 119
14. MONITORING AGENCY NAME & ADDRESS(If different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

For previous research published on TRACES, see AD A085660, AD A092784, AD A092680, and AD A107603

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Cost effectiveness	Resource allocation
Cost-benefit analysis	Marine Corps training
Benefit-cost analysis	Marine Air Command and Control S/3 (\CCS)
Combat readiness	MCCRES
Resource management	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The U.S. Marine Corps is in the process of developing a service-wide system for cost-effective allocation of training effort to ensure the combat readiness of its forces. This system is called TRACES (Training Requirements and Cost Evaluation System). As part of TRACES' development, Decisions and Designs, Inc. (DDI) is assisting the Marine Corps in developing a computer-based system for cost-effective allocation of training effort to units in the Marine Air Command and Control System

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(MACCS). A unit's training is to be assessed by its Marine Corps Combat Readiness Evaluation System (MCCRES) scores.

In 1979-1980, DDI assisted the Marine Corps in constructing a prototype benefit-cost TRACES model and accompanying computer software for infantry battalions. In the first phase of the current contract, DDI and Marine Corps personnel have determined the extent to which the benefit-cost approach used for infantry battalions would be applicable for the MACCS. The training options and readiness returns have had to be modified considerably in order to reflect basic differences in the training evolutions (and roles) of infantry battalions and the MACCS. Nevertheless, the benefit-cost approach used to implement TRACES with infantry battalions has been successfully extended to the MACCS. Furthermore, DDI has developed the computer software necessary to implement TRACES for the MACCS, i.e., the computer-based system for assessing the readiness return and accompanying costs obtained for the various MACCS training cycles.

TRACES was implemented in APL on the IBM 5110 computer and is intended to be a headquarters tool used by the MCCRES team. TRACES will require support if it is to be maintained and developed further. The future success of TRACES depends on how the Marine Corps will choose to use, maintain, and further improve the computer system.

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EXECUTIVE SUMMARY:
CONCLUSIONS AND RECOMMENDATIONS

The benefit-cost approach used to implement the Training
Requirements and Cost Evaluation System (TRACES) for infantry
battalions has been successfully extended to the Marine Air
Command and Control System (MACCS). Decisions and Designs, Inc.
(DDI) has developed the computer software necessary to implement
TRACES for the MACCS, and the system is ready for operational
use at U.S. Marine Corps Headquarters.

In considering future efforts, the first recommendation is
that the Marine Corps develop a MCCRES data management system to
store, record, and analyze the results of MCCRES evaluations.
This system also would provide automatic procedures for aggre-
gating the scores of separate MCCRES evaluations, which could
then be used as input to TRACES. Such a data management system
is essential for the cost-efficient monitoring of the strengths
and weakness of the various kinds of Marine Corps units as the
number of MCCRES evaluations increases over time. In addition,
the system would be capable of performing trend analyses to
identify whether allocated training resources had, in fact, re-
sulted in the expected readiness return.

The second recommendation is to develop a computer-based
TRACES for the entire Marine Air Ground Task Force (MAGTF).
The MAGTF TRACES would combine information from the MCCRES
volumes in an effort to determine the readiness returns from
the training exercises of those Marine Corps units for which
MCCRES standards apply. Although considerably more complex,

such a system could readily build upon the MACCS TRACES. The
MAGTF TRACES would require (1) development of an integrated
benefit-cost framework for infantry, aviation, and support
units, (2) cost and benefit assessments for each of these major
units, and (3) computer software incorporating an appropriately
tailored benefit-cost algorithm to identify those major train-
ing exercises that provide the most combat readiness return for
different levels of expenditure. Once developed, the MAGTF
TRACES would provide Marine Corps Headquarters with a system
for cost-effective allocation of training resources designed
to ensure MAGTAF readiness.

ACKNOWLEDGEMENTS

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TRAINING REQUIREMENTS AND COST EVALUATION SYSTEM
(TRACES) FOR MARINE AIR COMMAND AND CONTROL: PHASE I

1.0   INTRODUCTION

The U.S. Marine Corps is in the process of developing a
service-wide system for cost-effective allocation of training
effort to ensure the combat readiness of its forces. This
system is called TRACES, for Training Requirements and Cost
Evaluation System. As part of TRACES' development, the Marine
Corps is developing a computer-based system for cost-effective
allocation of training effort to units in the Marine Air
Command and Control System (MACCS). A unit's training is to
be assessed by its Marine Corps Combat Readiness Evaluation
System (MCCRES) scores.

Decisions and Designs, Inc. (DDI) has been tasked to
assist the Marine Corps in developing the computer-based system
for cost-effective allocation of training for the MACCS. DDI
has considerable experience in developing computer-based
systems to assist the Marine Corps. Through funding provided
by the Defense Advanced Research Projects Agency (DARPA), in
1976-1977, DDI assisted the Marine Corps in developing the
prototype multi-attribute utility assessment model and scoring
system used in MCCRES. In 1979-1980, through funding again
provided by DARPA, DDI assisted the Marine Corps in construct-
ing a prototype benefit-cost TRACES model and accompanying
computer software for infantry battalions.

In the first phase of the present contract, DDI analysts
were tasked to work with Marine Corps personnel to determine
the extent to which the benefit-cost approach used for infantry

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battalions would be applicable for the MACCS. This first
phase was completed successfully and the general benefit-cost
approach used for infantry battalions was found to be directly
applicable to the MACCS. The training options were modified
considerably, however, to reflect basic differences between
infantry battalion and MACCS training.

The training evolution of infantry battalions is predomi-
nantly based on a specific unit's deficiencies; a battalion
uses MCCRES to identify areas of weak performance and then
trains on those areas. Consequently, the computer software
developed for infantry battalions emphasizes training options
that can be scheduled by the battalions. Using the battalion's
MCCRES scores as inputs, the software identifies the training
option (a two- or three-day field exercise) that provides the
most benefit (i.e., combat readiness return) for specific
levels of cost.

The training evolution of the MACCS differs from the in-
fantry in two respects. First, it functions as a support
organization within the Marine Corps. It does not initiate an
exercise, but is required to support scheduled exercises.
Some latitude is available for determining which components of
the MACCS should participate, whether or not they will be de-
ployed, and what scenarios should be incorporated into an exer-
cise; but, the MACCS does not typically control the choice of
when and where to hold an exercise.

The second difference between the MACCS and infantry
training is that the MACCS is a system. It does not schedule
specific MCCRES evaluations directed towards identifying
problems within a specific MACCS. Instead, MACCS/MCCRES
evaluations are conducted in conjunction with major exercises.
They can only collect data on those tasks that are incorpo-

rated into an exercise. Moreover, they involve units that are together for the specific exercise, but which may or may not be together on the next exercise. Thus, the cycle of evaluate-train-evaluate within an infantry battalion is more difficult for the MACCS.

The MACCS approach to TRACES views MCCRES' evaluations as indicative of Marine Corps-wide deficiencies. In other words, no single MACCS/MCCRES evaluation is taken as a complete indicator of MACCS performance. Instead, the MACCS readiness benefits are formulated by aggregating MCCRES evaluations.

This emphasis on Marine Corps-wide readiness and the use of aggregated MCCRES scores implies that the MACCS' TRACES differs from the earlier infantry TRACES by being a major headquarters tool, rather than oriented towards a specific unit. First, a proper aggregation of the MCCRES evaluations is required by TRACES and can best be provided at a headquarters level. Second, the headquarters is the appropriate level for advocacy in favor of training options. In addition, units that provide a support role, such as those in the MACCS, require advocacy at that level. Finally, the costs of the training options represented in TRACES are committed at the headquarters level.

In summary, the training options and readiness returns have had to be modified considerably in order to reflect basic differences in the training evolutions (and roles) of infantry battalions and the MACCS. Nevertheless, the benefit-cost approach used to implement TRACES with infantry battalions has been successfully extended to the MACCS. Furthermore, DDI has developed the computer software necessary to implement TRACES for the MACCS, that is, the computer-based system for

assessing the readiness return and accompanying costs obtained
from the various MACCS training cycles.

The remainder of this report is divided into five parts.
Section 2.0 provides an illustrative example showing how the
Marine Corps can use TRACES to identify the best training allo-
cations for the MACCS. Section 3.0 describes the technical
approach for the benefit-cost analysis in TRACES. Section 4.0
outlines how to use TRACES. And, Section 5.0 discusses the
system support implications for TRACES.

2.0 USING TRACES TO IDENTIFY COST-EFFECTIVE DEPLOYMENT
CONFIGURATIONS FOR FIELD EXERCISE WITH A
MARINE AMPHIBIOUS FORCE: AN ILLUSTRATIVE EXAMPLE

The purpose of this example is to show how to use TRACES to select the deployment configuration for MACCS agencies that provides the most combat readiness return for specific levels of cost. The field exercise with a Marine Amphibious Force (MAF) was selected as the example because it represents the largest and most complex MACCS training option. TRACES will be capable of identifying the most cost-beneficial MACCS deployment configurations for ten other major training events.

The basic decision facing the MACCS personnel who are supporting a field exercise with a MAF is how to deploy the six agencies within the MACCS so they receive the highest combat readiness return for a specific level of cost. This decision problem is represented in Table 2-1. The six rows represent the six agencies in the MACCS and the columns represent the possible deployment configurations for these agencies. For example, the MACCS personnel could select (1) a nondeployed or deployed Tactical Air Command Center (TACC), (2) a nondeployed, an Early-Warning, or a deployed Tactical Air Operations Center (TAOC), (3) a full Direct Air Support Center (DASC) or a full plus a mini-DASC, (4) up to three batteries of Light Anti-Aircraft Missile (LAAM), (5) up to three Air Support Radar Teams (ASRTs), and, (6) up to two platoons of Forward Area Air Defense (FAAD) with ordnance. The MACCS chosen to support the field exercise with the MAF will be defined by the one deployment configuration selected for each of the six agencies.

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AGENCIES	DEPLOYMENT CONFIGURATIONS							
	1	2	3	4	5	7	8	9
TACC	Non-Deployed	Deployed						
TAOC	Non-Deployed	Early Warning	Deployed					
DASC	Full	Full + Mini						
LAAM	None	1 BTRY	2 BTRY	3 BTRY				
ASRT	None	1 ASRT No Ord- nance	1 ASRT Ord- nance	2 ASRT No Ord- nance	2 ASRT Ord- nance	3 ASRT No Ord- nance	3 ASRT Ord- nance	
FAAD	None	1 PLA- TOON No Ord- nance	1 PLA- TOON Dummy Ordnance	2 PLA- TOONS No Ord- nance	2 PLA- TOONS Dummy Ordnance			

Table 2-1

AN EXAMPLE OF MACCS DEPLOYMENT CONFIGURATION CHOICES
FOR A FIELD EXERCISE WITH A "AF

Each successive deployment configuration within each agency
will provide more training benefit, but for increased cost.
The problem is knowing which deployment configuration of the
agencies will provide the most cost-effective training for the
MACCS overall. Considering the present example, there are 1,120
(2x2x2x4x7x5) possible deployment configurations for a MACCS
supporting an integrated field exercise with a MAF. This situa-
tion is depicted in Figure 2-1. Each dot represents a different
deployment configuration in the benefit-cost space. The set of
dots tends to form a football-shaped region bounded above by
what is called, "the efficient frontier". The MACCS deployment
configurations on this frontier are the most cost-beneficial
configurations because they provide the most benefit (i.e.,
combat readiness return to the MACCS) for a given level of cost.
Consequently, MACCS personnel should select one of these con-
figurations in order to solve their decision problem.

MACCS personnel will be able to use TRACES to solve their
decision problem in one of two ways. First, they will be able
to identify the deployment configuration that provides the
most combat readiness return to the MACCS for a specified
cost. Second, they will be able to identify the deployment
configuration that provides a specified combat-readiness re-
turn for the least amount of money. These two capabilities
are illustrated in Figure 2-2. The efficient curve for field
exercise with a MAF is shown at the top of the figure; two
selected deployment configurations are shown below the curve.
For example, assume that MACCS personnel wanted to see the
best deployment configuration for about $100,000. After the
appropriate inputs, TRACES would indicate that, based on as-
sessments made by MACCS personnel (discussed in Section 3.2 of
this report), this would be a nondeployed TACC, a nondeployed
TAOC, a full DASC, one Battery of LAAM, no ASRTs ordinance, and
two platoons of FASD without ordinance. This is the MACCS
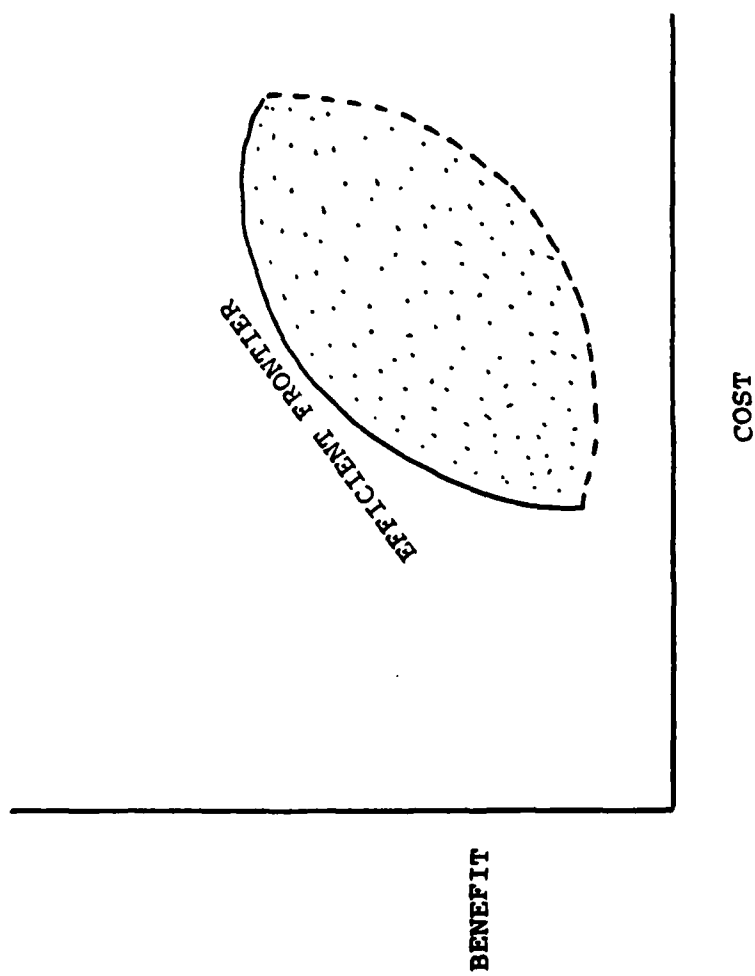
Figure 2-1

BENEFIT-COST REPRESENTATION OF POSSIBLE DEPLOYMENT CONFIGURATIONS
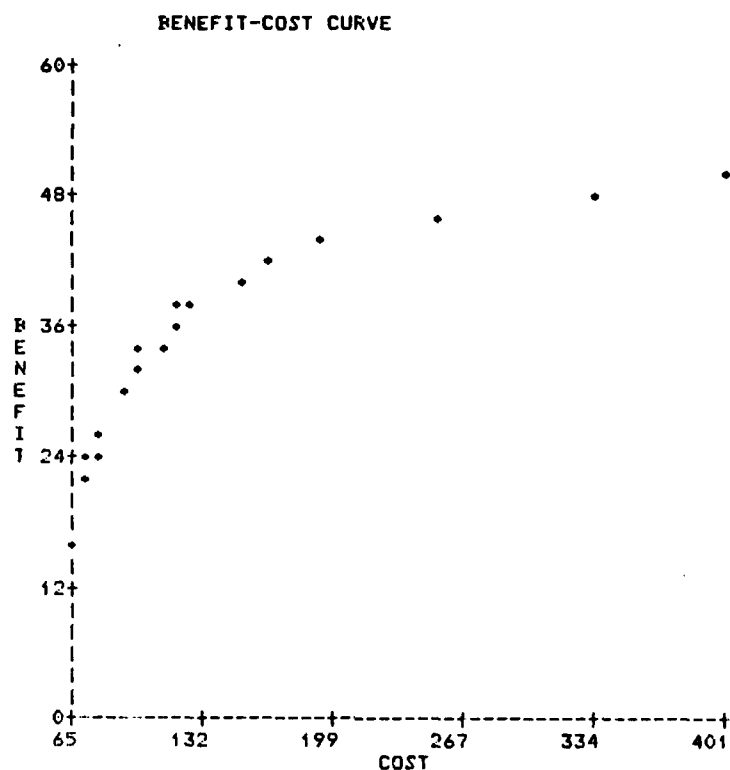
BENEFIT-COST CURVE

BEST EXERCISE
FX, WITH MAF;
 BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	FULL DASC
LAAM	1 (NO MI)
ASRT	NONE
FAAD	2 PL(-ORD)

COST	BENEFIT
97	33

BEST EXERCISE
FX, WITH MAF;
 BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	DEPLOY
DASC	FULL+MINI
LAAM	1 (NO MI)
ASRT	3 (WI ORD)
FAAD	2 PL(+DUM)

COST	BENEFIT
256	45

Figure 2-2

**USING TRACES TO SELECT THE BEST DEPLOYMENT
CONFIGURATION BASED ON COST AND ON BENEFIT**

deployment configuration on the efficient curve for $100,000. On the other hand, MACCS personnel might want to know which MACCS deployment configuration will result in a training benefit (i.e., combat readiness return) of 45 points on the next MCCRES evaluation for the least amount of money. For example, assuming that the MACCS received a score of 50 on its last MCCRES evaluation, a readiness return of 45 out of a possible 50 points would be a 90% training benefit. As shown in Figure 2-2, TRACES would indicate that, for an integrated field exercise with a MAF, this would be a nondeployed TACC, a deployed TAOC, a mini- and full-DASC, one LAAM battery, three ASRTs with ordnance, and two FAAD platoons with no ordnance. This is the MACCS deployment configuration that is on the efficient curve at a benefit level of 45 points.

TRACES has many capabilities in addition to being able to identify the best deployment configuration for a specific amount of money, and the least expensive configuration for a specific level of benefit. For example, MACCS personnel can evaluate the relative cost-effectiveness of a specified deployment configuration. This capability is illustrated in Figure 2-3. The proposed deployment configuration is identified by the P. The C identifies a MACCS deployment configuration that provides the same benefit for less money; the B identifies one that provides more benefit for the same cost. TRACES identifies the three deployment configurations below the graph. The proposed configuration contains the following:

- o   a deployed TACC
- o   a deployed TAOC
- o   a full DASC
- o   one battery of LAAM
- o   one ASRT with no ordinance
- o   one FAAD platoon with no ordinance

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BENEFIT-COST CURVE
(WITH PROPOSED, CHEAPER AND BETTER COMPOSITIONS)

BENEFIT axis: 60, 48, 36, 24, 12, 0

COST axis: 65, 132, 199, 267, 334, 401

PROPOSED EXERCISE
FX; WITH MAF;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	DEPLOY
TAOC	DEPLOY
DASC	FULL DASC
LAAM	1 (NO MI)
ASRT	1 (NO ORD)
FAAD	1 PL(-ORD)

COST	BENEFIT
241	38

CHEAPER EXERCISE
FX; WITH MAF;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	FULL DASC
LAAM	1 (NO MI)
ASRT	1 (WI ORD)
FAAD	2 PL(-ORD)

COST	BENEFIT
172	30

BETTER EXERCISE
FX; WITH MAF;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEFLOY
TAOC	NONDEFLOY
DASC	FULL+MINI
LAAM	1 (NO MI)
ASRT	3 (WI ORD)
FAAD	2 PL(+DUM)

COST	BENEFIT
191	45

Figure 2-3

USING TRACES TO IDENTIFY MORE COST-EFFECTIVE MACCS
DEPLOYMENT CONFIGURATIONS THAN THE ONE PROPOSED

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In our example, the MACCS would receive the same benefit
for about $120,000 less by not deploying the TACC or TAOC
and instead, by using a second platoon of FAAD. In contrast,
the MACCS could make up 6 more points for about $50,000 less
if it:

- o   did not deploy the TACC
- o   did not deploy the TAOC
- o   used a full and a mini DASC
- o   kept the one LAAM battery
- o   had three ASRT with ordnance
- o   had two FAAD platoons with dummy ordnance

At this point, the reader is no doubt wondering how
TRACES was able to identify these cost-effective deployment
configurations for supporting field exercises with a MAF. The
answer will become clear in the Technical Approach section
(Section 3.0). Suffice it to say now, for a given level of
money, TRACES uses benefit-cost ratios to identify deployment
configurations that exercise, on a cost-effective basis,
important Mission Performance Standards (MPSs) which, accord-
ing to the MCCRES data, have been poorly performed by impor-
tant MACCS agencies.

3.0 TECHNICAL APPROACH

This section describes the benefit-cost approach in
TRACES. The first part of the section describes the conceptual
framework of the training allocation system of which TRACES is
a part. The second part provides a general description of the
cost- and relative-effectiveness assessments incorporated into
TRACES.

3.1 Conceptual Framework

The training allocation system for the Marine Air Command
and Control System (MACCS) has two major components: (1) an
explicit evaluation model that specifies how well each agency
(and the MACCS overall) is performing each of its primary
tasks, and (2) an explicit training model that specifies the
most beneficial major training events and deployment con-
figurations for specific levels of cost. The components
were computerized to provide immediate information about the
areas of weak performance and, subsequently, the most cost-
beneficial training activities. Furthermore, to ensure its
utilization, the computerized system was designed in a
straightforward, user-oriented fashion that is not time-
consuming to operate.

MCCRES is the evaluation component of the system. It
incorporates a multi-attribute utility assessment (MAUA) model
that permits the systematic assessment of a unit's combat
readiness. In general, MAUA models are hierarchical in struc-
ture, starting with the specified top-level factor for which
an overall evaluation score is desired. This factor is suc-
cessively decomposed into subfactors, in descending levels of
the hierarchy, such that each successive level is more specific

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than the preceding one. The lowest level of the hierarchy contains those characteristics of the system which are readily predictable or observable. These lowest level, highly specific characteristics, are termed system elements.

Figure 3-1 presents a schematic of the MAUA model of MCCRES for the Marine Air Command and Control System (MACCS). The top-level factor is the overall combat readiness score. This factor is decomposed into an overall score for each agency in the MACCS. These scores are, in turn, decomposed into separate categories of standards that specify the appropriate mission performance standards (MPS) for the MCCRES evaluation for that agency. These standards are decomposed into specific tasks which, in turn, are decomposed into the specific requirements that represent observable activities. Thus, different activities are integrated systematically to provide evaluation scores on individual performance areas and thereby yield an overall performance score for the MACCS.

The MAUA model is used to provide an overall combat readiness score for the MACCS. First, Marine Corps evaluators rate whether the agencies did or did not satisfy each of their requirements during the MCCRES evaluation. An agency's score on each task is computed by differentially weighting the ratings on the requirements comprising that task. Consequently, an agency that failed to satisfy important requirements on a task would receive a low score on that particular task. In a similar fashion, the agency's score on each MPS is computed by differentially weighting the tasks comprising that MPS; a low score on an MPS implies that the agency performed poorly on important tasks within that MPS. The MPSs are differentially weighted to provide a score on the standards
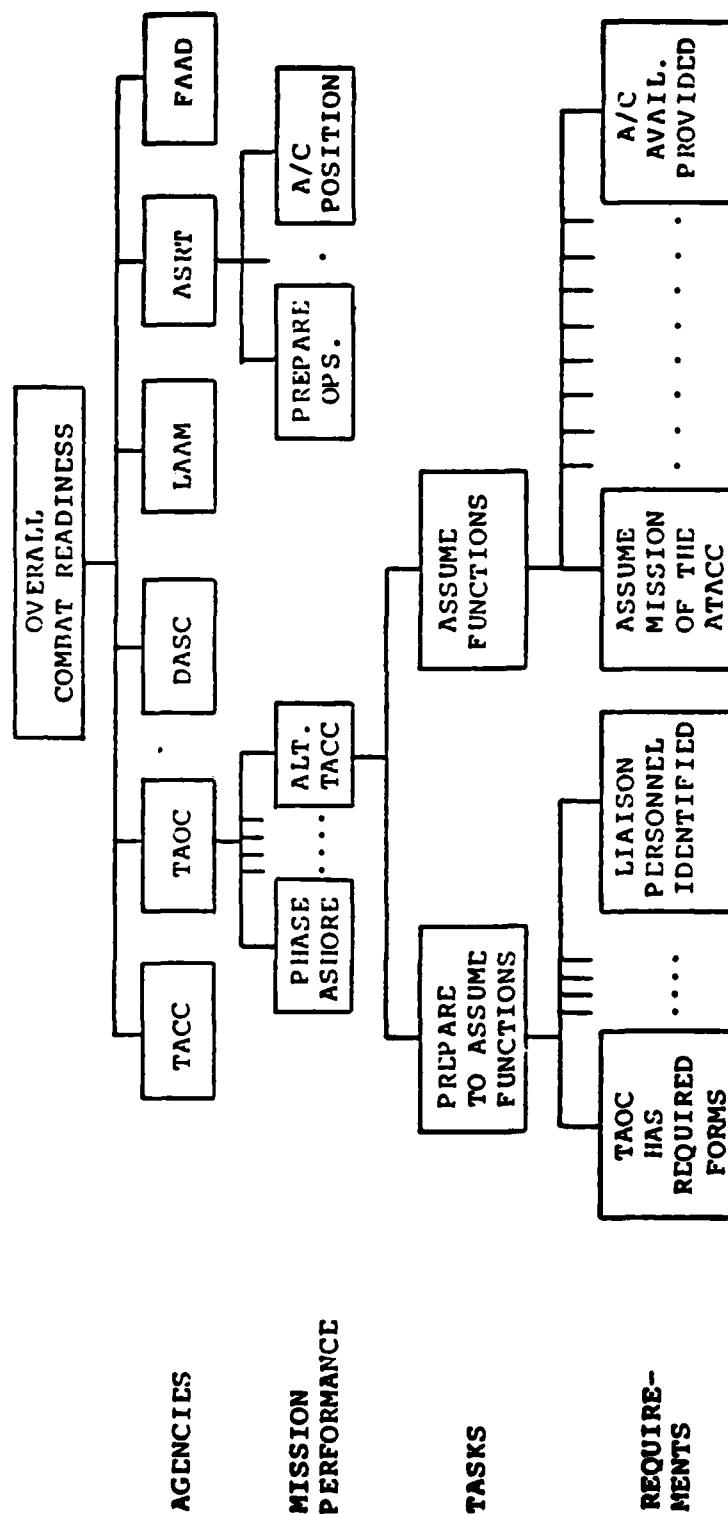
Figure 3-1

SCHEMATIC MAUA MODEL OF MCCRES FOR MARINE AIR COMMAND AND CONTROL

which, in turn, are differentially weighted to provide an overall combat readiness score for the agency. The more combat-ready the agency, the higher the overall score produced by the MCCRES evaluation. Poor overall performance can be readily attributed to poor performance on specific performance standards, tasks, and requirements. Finally, the agency's scores are differentially weighted to provide an overall combat readiness score for the MACCS.

TRACES is the training component of the system. The MCCRES scores are entered directly into TRACES. These scores can be those of a single MACCS or, as is more likely, those of the entire MACCS. (Marine Corps personnel determine overall scores by aggregating the MCCRES scores for a number of MACCS evaluations.) TRACES then specifies those training exercises that provide the most combat readiness return (i.e., benefit) for different levels of cost. The amount of combat readiness return is identified for each MACCS' agency, as well as for the MACCS overall.

TRACES organizes its representation of the training options in terms of major training events and the deployment configurations they will permit. These major training options were selected to reflect doctrinal, actual, and potential training exercises.

The eleven major training options differ by three factors:

1. The type of exercise (FX vs. CPX).

2. The degree of ground involvement (aviation only, with Marine Amphibious Unit, with Marine Amphibious Brigade, with Marine Amphibious Force.

3. The exercise scenario (air defense only, air support only, both air defense and air support).

This last factor captures the fact that exercises, excluding air defense or emphasizing it to the exclusion of air support, have been observed.

Figure 3-2 depicts the set of major training options encompassed by these factors. Although the full set includes twenty-four options, only eleven are considered by TRACES. The reasons for excluding options are:

1. Field exercises involving ground units will necessarily engage in air support activities.

2. MAF field exercises are too large to omit air defense.

3. All CPX's will involve both air support and air defense.

4. A MAU CPX is too small to involve the MACCS.

One of the eleven remaining options (the field exercise with MAU engaged in both air defense and air support) is feasible, but uncommon. It is included in TRACES as an experiment to assess its effectiveness. Thus, the eleven major training options are the following:

1. Field exercise with a MAF, both air support and air defense.

2. Field exercise with a MAB, both air support and air defense.

	FX			CPX		
	Air Defense	Air Defense	Both	Air Defense	Air Support	Both
Aviation Only	X	X	X			X
With MAU		X	X			
With MAB		X	X			X
With MAF			X			X

Figure 3-2

MAJOR TRAINING EVENTS USED BY TRACES

3.   Field exercise with a MAU, both air support and air defense.

4.   Field exercise with aviation only, both air support and air defense.

5.   Field exercise with a MAB, air support only

6.   Field exercise with a MAU, air support only.

7.   Field exercise with aviation only, air support only.

8.   Field exercise with aviation only, air defense.

9.   Command post exercise with a MAF only, air defense and air support.

10. Command post exercise with a MAB, air defense and air support.

11. Command post exercise with aviation only, air defense and air support.

For each major training event, each of six MACCS agencies (i.e., TACC, TAOC, DASC, LAAM, ASRT, and FAAD) was characterized in terms of varying levels of deployment. Section 2.0 presented the potential deployment configurations for a field exercise with a MAF. The potential deployment configurations for the ten other major training events are provided in Appendix A.

TRACES uses a general benefit-cost algorithm to identify the most cost-effective MACCS deployment configuration for

each of the selected major training options. Figure 3-3 presents a schematic of the benefit model within TRACES for the field exercise with the MAF, which was illustrated in Section 2.0. The benefit model includes the same MAUA hierachy as in MCCRES to ensure the explicit integration of the evaluation and training components of the overall system. The top-level factor is the overall benefit to the MACCS that is produced by any of the 1,120 possible deployment configurations that might be selected to support field exercises with the MAF. Overall benefit is decomposed into the benefits obtained for each agency which, in turn, are decomposed into the benefits obtained for each of the MPSs for that agency. (Marine Corps personnel thought the MPSs accurately reflected MACCS strengths and weaknesses; therefore, tasks and requirements were not included in the model.)

Working together, DDI analysts and Marine Corps personnel, obtained estimates of the relative training effectiveness on each MPS of each agency's alternative deployment configurations. In addition, the cost of the deployment configurations was also estimated. Both the cost and the training effectiveness estimates were assessed for the eleven major training events. Using these estimates, TRACES calculates a benefit-cost ratio for every deployment configuration. The greatest overall benefit is provided by deployment configurations that effectively exercise important MPSs for which poor performance was observed. The most cost-beneficial MACCS deployment configuration is the set of agency deployments that provides the greatest improvement in combat readiness, for the level of money available for training. That is, it is the option on the efficient curve for a specific cost level (e.g., see Figure 2-1). As the amount of money varies, the most cost-beneficial exercise varies. Marine Corps personnel will be

OVERALL TRAINING BENEFIT

TACC BENEF.	TAOC BENEF.	DASC BENEF.	LAAM BENEF.	ASRT BENEF.	FAAD BENEF.
MPSs	MPSs	MPSs	MPSs	MPSs	MPSs

EACH MAJOR TRAINING EVENT RESULTS IN A TRAINING BENEFIT FOR APPLICABLE MISSION PERFORMANCE STANDARDS. THESE CAN BE COMBINED INTO AN OVERALL TRAINING BENEFIT SCORE AND, IN TURN, A BENEFIT-TO-COST RATIO FOR EACH ALLOCATION CHOICE.
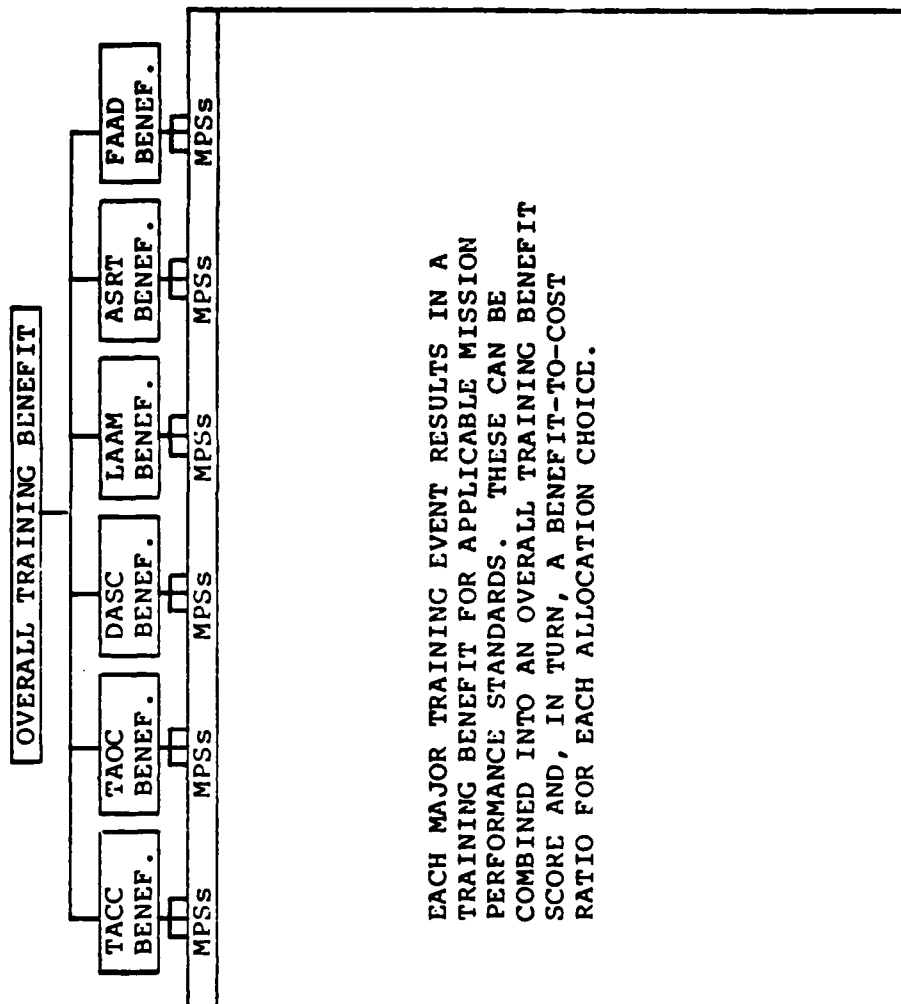
ALLOCATION CHOICES

TACC: Non-Deployed
Deployed TACC

TAOC: Non-Deployed
Early Warning
Deployed

DASC: DASC
DASC + Mini

LAAM: None
1 BTRY
2 BTRY
3 BTRY

ASRT: None
1 ASRT (no ord)
1 ASRT (w/ord)
2 ASRT (no ord)
2 ASRT (w/ord)
3 ASRT (no ord)
3 ASRT (w/ord)

FAAD: None
1 PLATOON (no ord)
1 PLATOON (w/ord)
2 PLATOONS (no ord)
2 PLATOONS (w/ord)

Figure 3-3

SCHEMATIC REPRESENTATION OF THE MACCS BENEFIT MODEL FOR RESOURCE ALLOCATION CHOICES IN A FIELD EXERCISE WITH A MARINE AMPHIBIOUS FORCE

able to use TRACES to identify the best deployment configuration for each of the eleven major training events.

In addition, Marine Corps personnel will be able to identify the major training event that produces the most combat readiness return to the MACCS for different levels of cost. This capability is achieved by comparing the costs and benefits for the deployment configurations that lie on the efficient curve for each major training event. This capability is represented schematically in Figure 3-4. In general, smaller training exercises cost the MACCS less to conduct, and produce less combat readiness return than the larger, more complex events. On occasion, however, full-scale deployment configurations of smaller events may provide the MACCS with more cost-effective training than is provided by relatively austere deployment configurations of larger events. TRACES will be able to identify these occasions, which are where the efficient curves cross each other in Figure 3-4. Such information should assist Marine Corps personnel in suggesting varied major training events, thereby facilitating cost-effective training for the MACCS.

In summary, the system has two major components: an explicit evaluation model (MCCRES) that specifies how well MACCS agencies are performing their functions, and an explicit training model (TRACES) that, based on the MCCRES scores, specifies the most beneficial major training events and deployment configurations for specific levels of cost. The training model includes all feasible MACCS deployment configurations for eleven major training options. The model also includes estimates of the relative training effectiveness and cost for each deployment configuration. Consequently, a benefit-cost ratio can be calculated for every deployment configuration; TRACES simply identifies the deployment configuration for the selected major event(s) that provides the highest total benefit-cost ratio at a specific level of cost.

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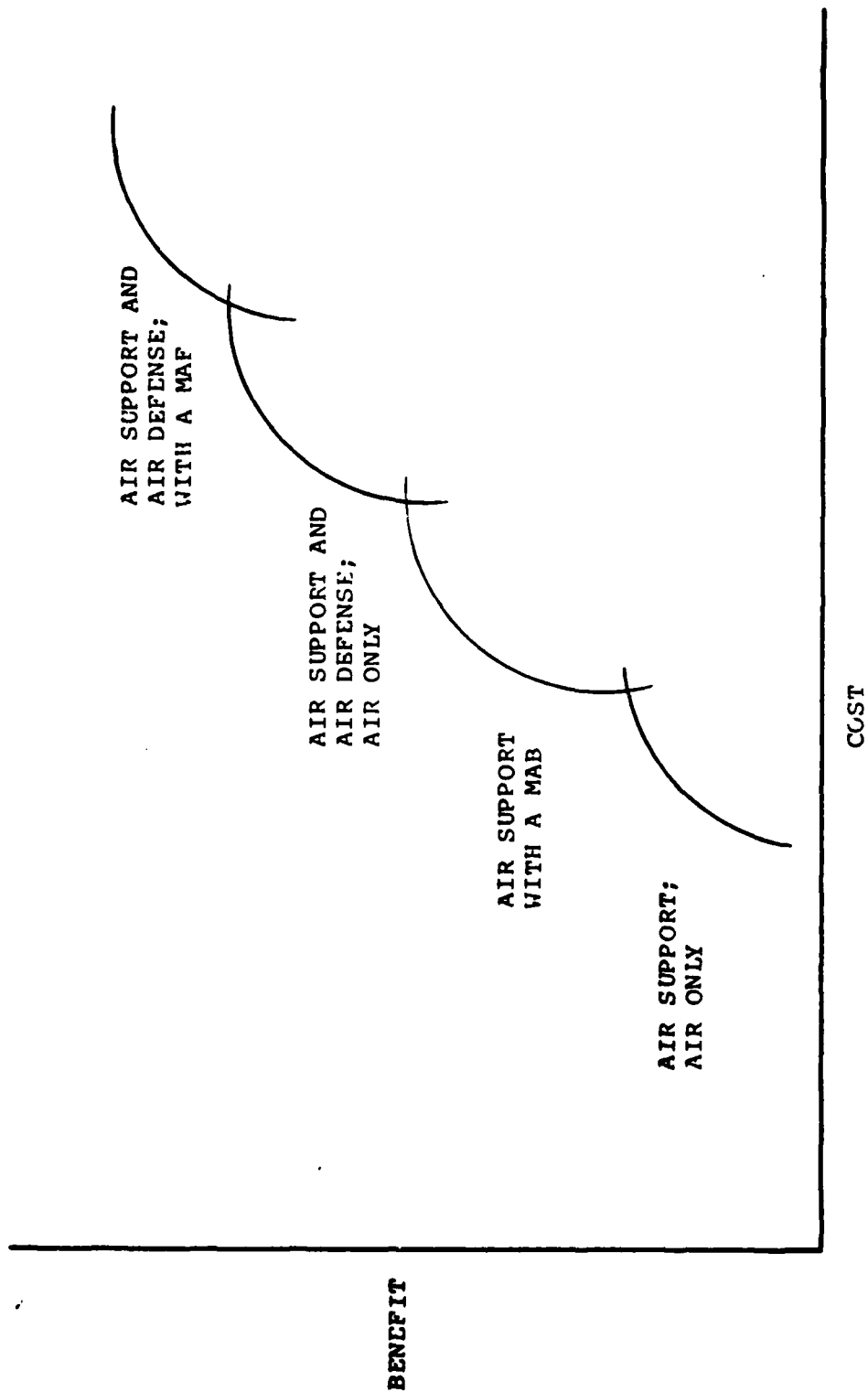
Figure 3-4

SCHEMATIC REPRESENTATION OF DEPLOYMENT CONFIGURATIONS
ON THE EFFICIENT FRONTIER FOR DIFFERENT MAJOR TRAINING EVENTS

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3.2 Costs and Effectiveness Assessments

Participating Marine Corps personnel assessed the cost
and relative effectiveness of each of the deployment configu-
rations for the eleven major training events. The assessments
for a field exercise with a MAF (illustrated in Section 2.0)
are described in this section to help the reader better under-
stand the technical approach used to implement TRACES. In
particular, Section 3.2.1 describes the cost assessments;
Section 3.2.2 describes the relative effectiveness (or bene-
fit) assessments; and Section 3.2.3 describes the calculations
used to determine the overall training benefit for a given
MACCS deployment configuration. The different deployment
configurations for a field exercise with a MAF are shown in
Table 3-1.

3.2.1 Costs - Current dollar figures of the operational
cost for different deployment configurations for each MACCS
agency are being collected by appropriate Marine Corps person-
nel. In lieu of more accurate cost data, estimates of the
operational cost of each MACCS deployment configuration for
each of the eleven major options have been assessed. The
estimates for a five-day, field exercise with a MAF are shown
in Table 3-2. The cost estimates for each configuration
include average travel costs. TRACES will, of course, permit
MACCS personnel to input the specific operational and travel
costs for particular units. In addition, TRACES permits users
to enter the fixed, non-operational dollar costs for each of
the eleven major options. Again, it must be stressed that
all cost estimates in Table 3-2 are for illustrative purposes;
they do not represent official Marine Corps cost figures.

AGENCIES	DEPLOYMENT CONFIGURATIONS							
	1	2	3	4	5	7	8	9
TACC	Non-Deployed	Deployed						
TAQC	Non-Deployed	Early Warning	Deployed					
DASC	Full	Full + Mini						
LAAM	None	1 BTRY	2 BTRY	3 BTRY				
ASRT	None	1 ASRT No Ordnance	1 ASRT Ordnance	2 ASRT No Ordnance	2 ASRT Ordnance	3 ASRT No Ordnance	3 ASRT Ordnance	
FAAD	None	1 PLATOON No Ordnance	1 PLATOON Dummy Ordnance	2 PLATOONS No Ordnance	2 PLATOONS Dummy Ordnance			

Table 3-1

MACCS DEPLOYMENT CONFIGURATION CHOICES FOR FIELD EXERCISE WITH A MAF

TACC:	Non-Deployed	$ 10,000
	Deployed	$ 75,000
TAOC:	Non-Deployed	$ 15,000
	Early Warning	$ 15,000
	Deployed	$ 80,000
DASC:	DASC	$ 40,000
	DASC + Mini	$ 55,000
LAAM:	None	0
	1 BTRY (No Missiles)	$ 20,000
	2 BTRY	$ 80,000
	3 BTRY	$100,000
ASRT:	None	$ 0
	1 ASRT (No Ord)	$ 20,000
	1 ASRT (With Ord)	$ 25,000
	2 ASRT (No Ord)	$ 40,000
	2 ASRT (With Ord)	$ 50,000
	3 ASRT (No Ord)	$ 60,000
	3 ASRT (With Ord)	$ 75,000
FAAD:	None	0
	1 Platoon (No Ord)	$ 6,000
	1 Platoon (With Dummy Ord)	$ 8,000
	2 Platoons (No Ord)	$ 12,000
	2 Platoons (With Dummy Ord)	$ 16,000

Table 3-2

ESTIMATED $ COST FOR EACH OF THE DEPLOYMENT
CONFIGURATIONS FOR A FIVE-DAY FIELD EXERCISE WITH A MAF

3.2.2 <u>Relative effectiveness assessments</u> - Some deployment configurations are more effective in training certain agencies than others, and even in training certain MPSs within agencies. Consequently, participating MACCS personnel estimated the relative effectiveness of each deployment configuration, for each of the eleven major events, in training each MPS for each MACCS agency. Relative effectiveness was defined as the percentage of the deficit made up (PDMU) on the agency's MPS by the chosen deployment configuration. The more effective the configuration in training a given MPS, the higher the PDMU. In all cases, it was assumed that the MACCS agency had received a score of 70 on its MCCRES evaluation in order to provide a baseline for estimating the PDMU for each deployment configuration. Furthermore, it was assumed that the relative effectiveness of a given configuration did not depend on the other choices.

Table 3-3 presents the relative effectiveness estimates (PDMUs) for the deployment configurations for a field exercise with MAF (includes air defense and air support), for the five MPSs for the Tactical Air Command Center (TACC). The table shows that a non-deployed TACC can be expected to make up:

o   Twenty percent of the deficit on the "phase control ashore" MPS.

o   Twenty-five percent of the deficit on the "display" MPS.

o   Sixty percent of the deficit on the "management of aircraft" MPS.

o   Ten percent of the deficit on the "external agencies" MPS.

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TACC

	PHASE CTL	DSPLY	MNG. A/C	EXT. AG.	SUCC OF C^2
TACC: Non-Deployed	20	25	60	10	35
Deployed TACC	50	25	60	30	45
TAOC: Non-Deployed	20	44	20	50	20
Early Warning	10	22	10	10	20
Deployed TAOC	22	44	20	70	30
DASC: DASC	20	25	20	0	15
DASC + Mini	22	25	20	0	15
LAAM: None	0	0	0	0	0
1 BTRY	2	2	0	0	5
2 BTRY	2	2	0	0	5
3 BTRY	2	2	0	0	5
ASRT: None	0	0	0	0	0
1 ASRT (no ord)	2	2	0	0	0
1 ASRT (w/ord)	2	2	0	0	0
2 ASRT (no ord)	2	2	0	0	0
2 ASRT (w/ord)	2	2	0	0	0
3 ASRT (no ord)	2	2	0	0	0
3 ASRT (w/ord)	2	2	0	0	0
FAAD: None	0	0	0	0	0
1 PLATOON (no ord)	2	2	0	0	5
1 PLATOON (w/ord)	2	2	0	0	5
2 PLATOONS (no ord)	2	2	0	0	5
2 PLATOONS (w/ord)	2	2	0	0	5

Table 3-3

RELATIVE EFFECTIVENESS SCORES FOR TACC
MPSs FOR A FIELD EXERCISE WITH A MAF

o   Thirty-five percent of the deficit on the
        "succession of command and control" MPS.

In contrast, a deployed TACC can be expected to make up 50, 25,
60, 30, and 45 percent, respectively, on the five MPSs, and so
forth. As can be seen, the relative effectiveness of the more
expensive deployed TACC, over the less expensive non-deployed
TACC, depends on the MPS. For example, the deployed TACC is
two and one-half times more effective on "phase control ashore,"
yet not any more effective on "management of aircraft," a MPS
for which a non-deployed TACC is extremely effective. Although
the relative effectiveness of different deployment configura-
tions depends on the MPS, the more inexpensive configuration for
each agency almost never provides more training benefit than the
most expensive configuration. (The only exceptions occur when
the firing of missiles in certain training events prohibits full
training on a MPS because of safety restrictions.)

        In designing a five-day field exercise with a MAF,
MACCS personnel must select one deployment configuration for
each of the six agencies in order to define the exercise. The
total benefit of that exercise for each MPS can be determined
by simply adding the PDMUs for the six selected levels. For
example, the least costly integrated field exercise with a
MAF, is composed of a nondeployed TACC, a nondeployed TAOC,
and a full DASC; there is no LAAM, ASRT, or FAAD. For the
TACC, this exercise can be expected to make up 60 percent of
the deficit in "phase control ashore": 20 percent by the non-
deployed TACC; 20 percent by the non-deployed TAOC; and 20 per-
cent by the full DASC. In contrast, the exercise can be expected
to make up 94 percent of the deficit in "display" and 100 percent
of the deficit in "manage aircraft." In a similar fashion, this
deployment configuration will make up a specific percentage of

the deficits (PDMUs) for the MPSs in each of the other five MACCS agencies.

In contrast, the most expensive exercise, that is, one comprised of a deployed TACC, a deployed TAOC, a mini- and a full DASC, three LAAM batteries, three ASRT with ordnance, and two FAAD platoons will make up 100 percent of the deficit on all five TACC MPSs. However, an examination of the PDMUs for the LAAM, ASRT, and FAAD reveals that the same readiness return to the TACC can be achieved by deploying only one of each of these types of agencies. The more expensive deployment configuration, however, may provide considerably more training on the important MPSs for the other five agencies, especially those on which a particular MACCS agency performed poorly; it may, therefore, be well worth the added training cost. TRACES will select the exercise, defined in terms of the level on each variable, that provides the most training benefit for specific levels of cost, across all MACCS agencies. These are the deployment configurations that lie on the efficient curve for a field exercise with a MAF (e.g., see Figure 2-2).

It is important to note that the relative effectiveness of individual deployment configurations depends on the major training event. Table 3-4, for example, presents the relative effectiveness scores (PDMUs) for a "field exercise with aviation only; air support." Three aspects of Table 3-4 should be noticed when compared to Table 3-3: First, there are fewer deployment configurations for an air support field exercise than for a field exercise with a MAF; for example, there is no deployed TAOC or LAAM or FAAD. Second,

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TACC

	PHASE CTL	DSPLY	MNG. A/C	EXT. AG.	SUCC OF C^2
TACC: Non-Deployed	20	15	40	10	35
Deployed TACC	40	15	40	20	45
TAOC: Non-Deployed	20	25	15	25	15
Early Warning	10	22	10	10	15
DASC: Non-Deployed	15	25	25	0	20
Mini	18	25	25	0	20
DASC	20	25	25	0	20
ASRT: 1 ASRT (no ord)	2	2	0	0	0
1 ASRT (w/ord)	2	2	0	0	0
2 ASRT (no ord)	2	4	0	0	0
2 ASRT (w/ord)	2	4	0	0	0
3 ASRT (no ord)	2	6	0	0	0
3 ASRT (w/ord)	2	6	0	0	0

Table 3-4

RELATIVE EFFECTIVENESS SCORES FOR TAAC
MPSs FOR A FIELD EXERCISE WITH AVIATION ONLY;
AIR SUPPORT

the same configurations often have smaller PDMUs for an air
support exercise because there is no training on air defense.
To illustrate, a deployed TACC within an air support exercise
is expected to make up only 40 percent of the deficit on "phase
control"; and to make up 50 percent of the deficit in a full
exercise. And third, the best air support exercise does not
make up 100 percent of the deficit in the MPSs. As an example,
a deployed TACC, a nondeployed TAOC, a DASC, and three ASRT
with ordnance make up only 45 percent of the deficit in the
"external agencies" MPS. This emphasizes the point that the
relative effectiveness of particular resources for training
depends on the larger training exercise of which they are a part.
Only the model for the field exercise with a MAF ensures that
the most expensive deployment configuration will make up 100
percent of the deficit on each MPS for each agency. (The rela-
tive effectiveness scores [PDMUs] for each level of each of
the eleven training events, for all six agencies' MPSs are pre-
sented in Appendix A.)

3.2.3 <u>Calculating the overall training benefit of a set
of resource allocation choices</u> - Training benefit will be de-
fined here as the number of MCCRES points that one can expect
to make up with a particular training exercise, where an exer-
cise is comprised of one, and only one, deployment configura-
tion for each agency. This measure of training benefit is
calculated in a series of steps. First, one calculates the
points made up (PMU) on each MPS for each deployment configu-
ration of each agency. This is the product of three terms:
(1) the PDMU for that MPS and deployment configuration (e.g.,
in a five-day field exercise with a MAF, a nondeployed TACC
can be expected to make up about 20 percent of the MCCRES defi-
cit on the TACC's ability to phase control ashore); (2) the
agency's MCCRES deficit on that MPS (e.g., assume that the TACC
scored a "70" on "phase control ashore"); and (3) the importance

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of that MPS. This step is illustrated with the following nota-
tion:

$$PMU_{i,j} = PDMU_{i,j} \times [100-Score_i] \times WT_i$$

where
i = the MPS
j = the deployment configuration.

Second, given a particular combination of deploy-
ment configurations for agencies, one calculates the total
points made up on an MPS, for that deployed configuration by
summing the appropriate $PMU_{i,j}$ values for that MPS. For
example, the total points made up on "phase control" for the
least expensive integrated field exercise with air only is
represented by the following operation:

$$PMU_{P.C.} = \sum_{j=1}^{6} PMU_j$$

where "j" represents the deployment configuration for
each of the six agencies.

Third, one calculates the total points made up for
an agency by a particular combined deployment configuration by
summing the points made up for all MPSs. As an illustration,

$$PMU_{TACC} = \sum_{i=1}^{5} PMU_i$$

where "i" represents the agency MPSs.

Finally, the overall points made up (PMU_{ov} by the
exercise are calculated by summing the product of the PMU for

each agency times its relative importance weight in MCCRES. That is,

$$PMU_{ov} = \sum_{a=1}^{6} PMU_a \times WT_a$$

where "a" represents the MACCS agencies.

The most beneficial major training option for a specific level of cost is the exercise that makes up the most points overall (i.e., has the highest PMU_{ov}) for that level of cost.

The predicted MCCRES score for a MACCS agency's next evaluation, assuming the designated training occurs, is its previous MCCRES score, plus the estimated overall PMU. TRACES, however, cannot guarantee that the unit will receive this score. The PDMUs and, in turn, PMUs are expected values; they represent only how well the unit can be expected to perform on the average. These values represent the best judgment of MACCS personnel who participated in the study. They are, of course, subject to revision on the basis of future evaluations of training effectiveness.

It is important to mention two additional technical points. First, at times there will be no LAAM, ASRT, or FAAD in a given deployment configuration. When this occurs, TRACES automatically assigns a PDMU value of zero to the MPSs for the appropriate agency(ies), i.e., LAAM, ASRT, or FAAD. Second, strictly speaking, overall benefit should be calculated by a multiplicative, not an additive rule. For if the deployment configuration for an agency makes up p_1 percent of the deficit, the deployment configuration for a second agency can make up only $(1-p_1) \times p_2$ percent of the deficit. The multiplicative rule was not used because it implies that one cannot guarantee that even the most expensive possible deployment

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configuration will make up 100 percent of the deficit. This was unacceptable to participating MACCS personnel. Since the difference between the overall benefit values calculated with the additive and multiplicative rules is so slight using a baseline MCCRES score of 70, we used the additive rule.

4.0 USER INTERFACE

The user interface of a computer system includes the methods by which the user provides input to the computer, the methods by which the user controls the computer, and the displays and printouts provided by the computer. This is the level at which a user typically understands a system. The technical details, although vital, are usually treated as a "black box." The user's perspective is largely a matter of what he must do to the system and what he will obtain from it.

TRACES was implemented on the IBM 5110/20 portable computer for use at Marine Corps Headquarters (see Appendix B for a description of how to use this computer). The user's interaction with TRACES is organized in terms of menus. These menus display a set of user options, which can be selected by typing the number associated with the desired option. This is a very effective technique for enabling a casual or untrained user to control a system.

The TRACES software package is divided into three parts, called workspaces. The EDIT workspace permits the user to modify the values in TRACES. The SOLVE workspace permits the user to perform the benefit-cost analysis for one or more major training events. The ANALYZE workspace permits the user to examine the results of the benefit-cost analysis performed in SOLVE. Users select the workspace they want to use at a given time by typing)LOAD EDIT or)LOAD SOLVE or)LOAD ANALYZE. Each workspace has a set of main options. Figure 4-1 presents the main options for each of the three workspaces. The next three subsections describe how to use the options in each of the three workspaces.

MAIN MENU

1. EDIT   TRACES EDIT MAIN OPTIONS
                         1)   ENTER/EDIT MCCRESS SCORES
                         2)   MODIFY AGENCY WEIGHTS
                         3)   MODIFY MPS WEIGHTS
                         4)   MODIFY FIXED COSTS
                         5)   MODIFY OPERATING COSTS
                         6)   MODIFY PDMUS
                         7)   ADD A MPS
                         8)   DELETE A MPS
                         9)   PRINT DATA

2. SOLVE   UNSOLVED MAJOR OPTIONS
                         1)   FX; with MAF; BOTH AD+AS
                         2)   FX; WITH MAB; BOTH AD+AS
                         3)   FX; WITH MAU; BOTH AD+AS
                         4)   FX; AIR ONLY; BOTH AD+AS
                         5)   FX; WITH MAB; AIR SUPPORT ONLY
                         6)   FX; WITH MAU; AIR SUPPORT ONLY
                         7)   FX; AIR ONLY; AIR SUPPORT ONLY
                         8)   FX; AIR ONLY; AIR DEFENSE ONLY
                         9)   CPX; WITH MAB; BOTH AD+AS
                        10)   CPX; WITH MAB; BOTH AD+AS
                        11)   CPX; AIR ONLY; BOTH AD+AS
                        12)   ALL

3. ANALYZE   ANALYZE MENU
                         1)   ANALYZE PROPOSED EXERCISE
                         2)   ANALYZE BEST EXERCISE
                         3)   ANALYZE SET OF BEST EXERCISES

Figure 4-1

MAIN OPTIONS FOR EACH MAJOR WORKSPACE IN TRACES

4.1 Using the EDIT Workspace

TRACES computations are based upon estimates that have
been derived prior to their usage. These assessments
represent the best estimate of the moment and embody much
detailed knowledge about the MACCS. They are not, however,
infallible. The EDIT workspace permits users to modify these
assessments.

Before discussing individually the EDIT options presented
in Figure 4-1, two considerations deserve mention. First,
assessment modifications should be made with care and only by
personnel who are familiar with the computational underpinnings
of TRACES. The current assessments are the product of lengthy
and detailed discussion (especially the PDMUs) and should,
therefore, be given the benefit of the doubt. Furthermore,
TRACES stores the changes, not the initial assessments. Conse-
quently, changes should require thorough justification.

Second, modifications to the assessments constitute a
change in the models. Therefore, upon leaving EDIT, users
must first enter SOLVE to perform the necessary benefit-cost
calculations and then enter ANALYZE to examine the results of
these calculations. Since the benefit-cost calculations may
take up to thirty minutes to perform, depending on the nature
of the changes in EDIT, users should make changes judiciously.
In addition, they should get most, if not all, available print-
outs in ANALYZE and EDIT before making these changes, in order
to have a record of the previous analysis.

There are nine main menu items in the EDIT workspace, as
shown in Figure 4-1. Each option is described below.

4.1.1 <u>Enter MCCRES scores</u> - A TRACES analysis begins
with the entry of a new set of MCCRES scores. This is
accomplished in the MACCS TRACES by having the user directly
modify (or edit) the MCCRES scores last entered into TRACES.
Unlike the earlier TRACES developed for the Infantry, the
present system does not read MCCRES data directly from a
MCCRESSA diskette. This change of procedure was required by
the change in perspective that views the MCCRES for the MACCS
as a way of measuring Marine Corps-wide readiness rather than
individual unit readiness. Any single MCCRES evaluation is
seen as only one observation of many. The appropriate input
to TRACES is not the single observation, but an aggregated
performance over many evaluations. However, since an automatic
technique is not available to aggregate MCCRES evaluations, this
must be done by the user and the resulting data entered into
TRACES by hand. Since there are only twenty-five MPSs for the
MACCS, the twenty-five MCCRES scores for those MPSs can be en-
tered quickly by hand.

It should be noted here that there are three
additional reasons for providing a capability to modify MCCRES
scores. First, scores that were previously entered and stored
may require only slight modification to reflect a new
evaluation summary. Second, it may seem appropriate to
conduct sensitivity analyses by systematically varying a
particular score. And finally, a score may be in error and
require editing.

4.1.2 <u>Modify agency weights</u> - The overall MCCRES score
for a MACCS depends on the relative importance of the
performance of the six different agencies. For example, if
the performance of the TACC is more important than the
performance of the LAAM, then the TACC would have a larger
agency weight than the LAAM in MCCRES. For similar reasons,

the TACC would have a larger agency weight than the LAAM in TRACES, implying that improving the performance of the TACC would be more important than improving the performance of the LAAM.

In most cases, the performance level of each MACCS agency will be equally important. TRACES is designed so that the agency weights will be normalized automatically to sum to 100, as it does in MCCRES. For example, if the users type an agency weight of 5 for each of the six agencies, TRACES automatically will assign an agency weight of 16.66 (rounded off to 17) to each of the agencies. In contrast, if the users think that, for example, the performance of the TACC is 3 times as important as the performance of the TAOC, whose performance, in turn, is just as important as the other four agencies, the users could assign an agency weight of 3 to the TACC and an agency weight of 1 to each of the other agencies; TRACES will normalize the weights to be 37.5 for the TACC and 12.5 for the other agencies. If the users do not want to consider the performance (or readiness return) of a particular agency, they should assign it an agency weight of 0.

4.1.3 Modify MPS weights - The overall MCCRES score for an agency depends on the relative importance of its MPSs. Consequently, major training options and deployment configurations that effectively exercise important MPSs on which an agency performed poorly will result in a greater readiness return and, in turn, higher MCCRES score for that agency, than exercises and configurations that do not. In TRACES, weights for the MPSS within an agency were initialized to be equal to each other. TRACES also permits users to modify the MPS weights in order to perform sensitivity analyses. TRACES automatically normalizes the modified MPS weights so that they sum to 100 as in MCCRES.

4.1.4 <u>Modify fixed costs</u> - Fixed costs are costs associated with a major training option and are modifiable upon designation of the appropriate major training option. This causes the current estimate to be displayed and offered for modification. At present, there are no fixed costs in TRACES; these costs can be entered readily by Marine Corps personnel prior to using TRACES in an operational environment.

4.1.5 <u>Modify operational costs</u> - Operational costs are associated with the operational deployment configuration of the MACCS. They can be modified when both a major training option and deployment configurations are specified for an agency. The current cost estimate is displayed and offered for modification. At present, TRACES has estimates of operational costs which do not represent official Marine Corps cost figures. Official cost figures can be entered readily by Marine Corps personnel prior to using TRACES in an operational environment.

4.1.6 <u>Modify percent deficit made up (PDMU)</u> - The percent deficit made up (PDMU) by each deployment configuration on each mission performance standard (MPS) is the core of the TRACES analysis. It relates readiness return to cost. Although TRACES allows for the modification of these assessments, <u>this should be done with great care</u>.

To specify a PDMU for modification, the user is first asked to identify a major training event and then the agency, MPS, and deployment configuration for which the PDMUs are to be changed. At this point, TRACES displays the current PDMU value and changes can be made by the user. If the user inadvertently enters a number that implies that a deployment configuration provides more than 100% of the deficit made up, TRACES asks the user to specify new PDMU values.

Appendix A shows the PDMU values for all eleven major options. The PDMU values for an integrated field exercise with a MAU (i.e., major option #3) still need to be assessed and entered into TRACES.

4.1.7 Add a MPS - Modifications to the structure of TRACES have the most far-reaching effects on the TRACES analysis. When MPSs are added or deleted the PDMU assessments and weights must be reviewed for accuracy and completeness. Since there is no simple way to do this automatically, extreme care is required when selecting these options. When a MPS is added to an agency, TRACES initializes its PDMUs and weight to zero. TRACES also warns users that these values need modification; consequently, users should select the appropriate EDIT options after adding the MPS. Users must then enter SOLVE to perform the benefit-cost analysis after making the modifications.

4.1.8 Delete a MPS - Should the user decide to delete an MPS, the problem is relatively simple. The PDMUs and weight associated with the MPS are eliminated. In addition, the weights of the other MPSs within that agency are normalized to add up to 100. Finally, the user is advised to review all weights, lest the deletion has affected his estimate of the importance of an agency or MPS. Since MPS deletion does change the assessments, benefit-cost analysis is required, following selection of this suboption.

4.1.9 Print data - TRACES provides users with three options for the type of data they want printed. First, users can print agency and MPS weights and scores. This option is illustrated in Figure 4-2 for equal agency weights, equal MPS weights within each agency, and a MCCRES score of 50 on each MPS. Second, users can print the fixed and operational costs for the deployment configurations of selected major training

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                        WEIGHTS AND SCORES

          -----------------------------------------------
                AGENCY              MPS
             WT   NAME      WT      NAME       SCORE
          -----------------------------------------------


             ( 17) TACC  ( 20) PHASE CNTL  ( 50)
                         ( 20) DSPLY       ( 50)
                         ( 20) MNG A/C     ( 50)
                         ( 20) EXT AG      ( 50)
                         ( 20) SUC OF C+C  ( 50)

             ( 17) TAOC  ( 17) PHASE CTNL  ( 50)
                         ( 17) RADAR SURV  ( 50)
                         ( 17) ENGAGE CTL  ( 50)
                         ( 17) EMIS CNTL   ( 50)
                         ( 17) AIRSP MGMT  ( 50)
                         ( 17) ALT TACC    ( 50)

             ( 17) DASC  ( 20) PHASE CNTL  ( 50)
                         ( 20) PRE-PLAN    ( 50)
                         ( 20) IMMEDIATE   ( 50)
                         ( 20) AIR DEFENS  ( 50)
                         ( 20) REPORTS     ( 50)

             ( 17) LAAM  ( 33) SETUP       ( 50)
                         ( 33) ENGAGE      ( 50)
                         ( 33) ECM         ( 50)

             ( 17) ASRT  ( 33) OPS PREP    ( 50)
                         ( 33) BOMB CNTL   ( 50)
                         ( 33) POSITION    ( 50)

             ( 17) FAAD  ( 33) PHASE CNTL  ( 50)
                         ( 33) ENGAGE      ( 50)
                         ( 33) SUPPORT     ( 50)


          -----------------------------------------------
```

Figure 4-2

**ILLUSTRATION OF THE "PRINT MPS WEIGHTS AND SCORES"
OPTION IN THE "EDIT MENU"**

options. This option is illustrated in Figure 4-3 for an
integrated field exercise with a MAF and the operational costs
listed in Table 3-2; there were no fixed costs. And third,
users can print either all the PDMU values for selected major
options (i.e., for all six agencies) or all the PDMU values
for a selected MPS (i.e., for all major options). The former
capability is illustrated in Figure 4-4; the latter capability
is illustrated in Figure 4-5. (The dashed lines indicate that
the deployment configuration is not a realistic one for that
particular major option.)

4.2 Using the SOLVE Workspace

The SOLVE Workspace performs the benefit-cost analysis
for the major training options selected by the user. As shown
in Figure 4-1, the user can have the analysis performed for
just one major option, for two or more options, or for all the
options. If only one major option is selected, for example,
"FX; WITH MAF; BOTH AD + AS," SOLVE performs the benefit-cost
analysis described in Sections 2.0 and 3.0 (in terms of the cost
versus readiness benefit from that training option). The set of
optimal deployment configurations is then presented to the
user in the ANALYZE workspace.

4.3 Using the ANALYZE Workspace

The ANALYZE workspace permits users to examine the results
of the benefit-cost analysis performed in SOLVE. Users can
examine the analysis for any major option individually or in
relation to two or more options (e.g., "FX; WITH MAF; BOTH AD +
AS" and "FX; WITH MAB; BOTH AD + AS") by typing their numbers,
separated by a space, on the same line (e.g., 1 2). In this
case, the best deployment configurations from the designated
set of events will be evaluated in relation to one another.

```
                      COST DATA FOR
        MAJOR OPTION: FX; WITH MAF; BOTH AD+AS

                      FIXED COST: 0

        ------------------------------------
        AGENCY  DEPLOYMENT       COST
        ------------------------------------


        TACC:   NONDEPLOY         10
                DEPLOY            75

        TAOC:   NONDEPLOY         15
                EARLY WARN        16
                DEPLOY            80

        DASC:   FULL DASC         40
                FULL+MINI         55

        LAAM:   NONE               0
                1 (NO MI)         20
                2 (NO MI)         80
                3 (NO MI)        100

        ASRT:   NONE               0
                1 (NO ORD)        20
                1 (WI ORD)        25
                2 (NO ORD)        40
                2 (WI ORD)        50
                3 (NO ORD)        60
                3 (WI ORD)        75

        FAAD:   NONE               0
                1 PL(-ORD)         6
                1 PL(+DUM)         8
                2 PL(-ORD)        12
                2 PL(+DUM)        16
        ------------------------------------
```

Figure 4-3

**ILLUSTRATION OF THE "PRINT COSTS"
OPTION IN THE "EDIT MENU"**

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PERCENT DEFICIT MADE-UP (PDMUS)
FOR MAJOR OPTION: FX, WITH MAF, BOTH AD+AS

		TACC					TAOC						DASC					LAAM			ASRT			FAAD		
		PHASE CNTL	DSPLY	MNG A/C	EXT AG	SUC OF C+C	PHASE CTL	RADAR SURV	ENGAGE CTL	EXIS CNTL	FIRST MGMT	ALT TACC	PHASE CNTL	PREPLAN	IMMEDIATE	AIR DEFENS	AIR REPORTS	SETUP	ENGAGE	ECM	OPS PREP	ROMB CNTL	POSITION	PHASE CNTL	ENGAGE	SUPPORT
TACC:	NONDEPLOY	20	25	55	20	35	10	3	6	17	20	20	10	30	25	10	30	0	5	5	0	0	0	5	2	0
	DEPLOY	50	25	55	40	45	12	3	6	17	20	25	15	35	32	10	30	0	5	5	0	0	0	5	2	0
TAOC:	NONDEPLOY	20	40	20	40	20	10	10	30	25	40	40	10	10	7	20	5	30	25	30	5	10	0	10	5	0
	EARLY WARN	10	20	10	10	20	35	30	35	27	25	30	10	10	7	10	5	15	10	45	5	10	0	5	2	0
	DEPLOY	22	40	20	60	30	50	40	40	30	45	50	15	10	7	20	5	30	30	30	5	10	0	10	5	0
DASC:	FULL DASC	20	20	25	0	15	11	7	3	13	20	15	40	40	40	40	35	0	0	0	15	20	0	15	10	25
	FULL+MINI	22	20	25	0	15	12	7	3	15	22	20	50	45	45	40	38	0	0	0	20	25	0	16	10	25
LAAM:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO MI)	2	5	0	0	5	5	25	30	25	3	5	3	0	0	0	30	40	25	30	0	0	0	5	9	0
	2 (NO MI)	2	8	0	0	5	13	35	35	27	3	5	3	0	12	1	45	50	30	45	0	0	0	7	11	0
	3 (NO MI)	2	10	0	0	5	16	40	40	30	3	5	3	0	14	1	60	60	35	60	0	0	0	9	13	0
ASRT:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO ORD)	2	1	0	0	0	1	1	1	2	1	0	5	3	5	1	15	0	0	0	30	30	15	0	0	0
	1 (WI ORD)	2	1	0	0	0	1	1	1	2	1	0	5	3	5	1	15	0	0	0	35	35	45	0	0	0
	2 (NO ORD)	2	2	0	0	0	2	2	2	2	4	0	5	6	10	1	20	0	0	0	45	50	26	0	0	0
	2 (WI ORD)	2	2	0	0	0	3	3	2	2	6	0	5	6	10	1	20	0	0	0	60	55	80	0	0	0
	3 (NO ORD)	2	3	0	0	0	3	3	2	2	8	0	5	9	15	1	25	0	0	0	50	60	32	0	0	0
	3 (WI ORD)	2	3	0	0	0	3	3	2	2	8	0	5	9	15	1	25	0	0	0	75	65	96	0	0	0
FAAD:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 FL(-ORD)	2	2	0	0	5	5	5	5	1	1	0	10	1	1	1	1	5	10	5	0	0	0	45	45	40
	1 FL(+DUM)	2	2	0	0	5	5	5	5	1	1	0	10	1	1	1	1	5	10	5	0	0	0	45	55	50
	2 FL(-ORD)	2	2	0	0	5	7	7	7	2	2	0	12	1	15	1	1	10	10	5	0	0	0	60	70	60
	2 FL(+DUM)	2	2	0	0	5	7	7	7	2	2	0	12	1	15	1	1	10	10	5	0	0	0	60	70	75

Figure 4-4

THE PDMU VALUES FOR ALL AGENCIES FOR
AN INTEGRATED FIELD EXERCISE WITH A MAF

PERCENT DEFICIT MADE-UP (PDMUS)
BY EACH MAJOR OPTION FOR A SPECIFIED MFS

AGENCY: TACC
MFS: PHASE CNTL

MAJOR OPTIONS:	1	2	3	4	5	6	7	8	9	10	11
TACC: NONDEPLOY	20	20	0	20	20	15	20	20	20	20	20
DEPLOY	50	50	--	50	--	5	40	40	40	40	--
TAOC: NONDEPLOY	20	20	--	20	20	15	20	20	20	20	20
EARLY WARN	10	10	0	10	10	--	10	10	--	--	--
DEPLOY	22	22	--	22	--	--	--	22	--	--	--
DASC: NONDEPLOY	--	--	--	--	--	--	15	15	--	--	15
MINI DASC	--	20	--	18	20	15	18	18	20	20	18
FULL DASC	20	20	0	20	20	--	20	--	20	20	--
FULL+MINI	22	22	--	22	20	--	--	--	--	--	--
LAAM: NONE	0	0	0	0	0	0	0	0	0	0	0
1 (NO MI)	2	2	--	2	--	--	--	2	1	1	1
2 (NO MI)	2	2	--	2	--	--	--	2	1	1	1
3 (NO MI)	2	2	--	2	--	--	--	2	1	1	1
1 (WI MI)	--	--	--	2	--	--	--	2	--	--	--
2 (WI MI)	--	--	--	2	--	--	--	2	--	--	--
3 (WI MI)	--	--	--	2	--	--	--	2	--	--	--
ASRT: NONE	0	0	0	0	0	0	0	0	0	0	0
1 (NO ORD)	2	2	--	2	2	--	2	--	--	--	--
1 (WI ORD)	2	2	0	2	2	1	2	--	1	--	1
2 (NO ORD)	2	--	--	2	--	--	2	--	--	--	--
2 (WI ORD)	2	--	--	2	--	--	2	--	--	--	--
3 (NO ORD)	2	--	--	2	--	--	2	--	--	--	--
3 (WI ORD)	2	--	--	2	--	--	2	--	--	--	--
FAAD: NONE	0	0	0	0	0	0	0	0	0	0	0
1 SC(-ORD)	--	2	0	2	2	1	--	--	--	--	--
1 SC(+DUM)	--	2	0	2	2	1	--	--	--	--	--
1 PL(-ORD)	2	2	0	2	--	--	--	--	--	--	--
1 PL(+DUM)	2	2	--	2	--	--	--	--	--	--	--
1 PL(MISS)	--	--	--	2	--	--	--	--	--	--	--
2 PL(-ORD)	2	--	--	2	--	--	--	2	--	--	--
2 PL(+DUM)	2	--	--	2	--	--	--	2	--	--	--
2 PL(MISS)	--	--	--	2	--	--	--	2	--	--	--

LEGEND OF MAJOR OPTIONS

1) FX; WITH MAF; BOTH AD+AS
2) FX; WITH MAR; BOTH AD+AS
3) FX; WITH MAU; BOTH AD+AS
4) FX; AIR ONLY; BOTH AD+AS
5) FX; WITH MAR; AIR SUPPORT ONLY
6) FX; WITH MAU; AIR SUPPORT ONLY
7) FX; AIR ONLY; AIR SUPPORT ONLY
8) FX; AIR ONLY; AIR DEFENSE ONLY
9) CFX; WITH MAF; BOTH AD+AS
10) CFX; WITH MAR; BOTH AD+AS
11) CFX; AIR ONLY; BOTH AD+AS

Figure 4-5

THE PDMU VALUES FOR ALL MAJOR OPTIONS
FOR THE PHASE CONTROL ASHORE MPS IN TALL

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Should any deployment configurations from one major event dominate those of another, only the best event will be shown to the user.

Figure 4-6 depicts the method by which optimal deployment configurations from two major options are compared. The points marked A and B represent optimal configurations for major options A and B, respectively. Although these configurations may be optimal when the major option is considered in isolation, not all are optimal when the two major options are compared. In particular, the circled points correspond to deployment configurations that are dominated by a configuration based on the other major option. They are, therefore, suboptimal when both major options are being considered. The technique for finding the optimal configurations for two major options is easily extended to encompass larger sets of major options.

The selection of the major options for consideration is an important step in a TRACES analysis. The user should include any major training options that are plausible and avoid including ones that are totally unrealistic, given his constraints.

As shown in Figure 4-1, there are three main options in ANALYZE. The "ANALYZE PROPOSED EXERCISE" permits users to specify an exercise (i.e., major training option and deployment configuration), and then examine whether it lies on the efficient frontier. The "ANALYZE BEST EXERCISE" permits users to examine the one exercise that lies on the efficient frontier for the particular level of cost or benefit that they specify. And the "ANALYZE SET OF BEST OPTIONS" prints in sequential order all the exercises on the efficient frontier, from the least to most expensive exercise. Each of these three main options is considered in more detail below.
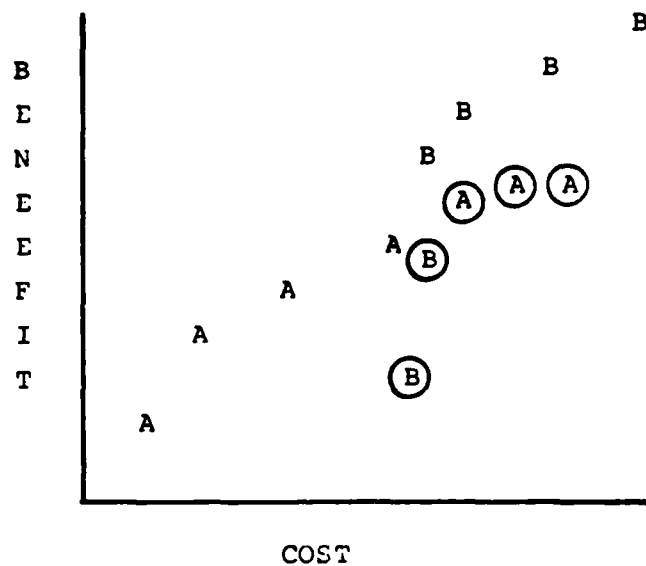
Figure 4-6

THE BEST DEPLOYMENT CONFIGURATIONS FROM
TWO MAJOR TRAINING EVENTS (A AND B)

4.3.1 <u>Analyze proposed exercise</u> - An integral component of the cost-benefit approach is the ability to specify a proposed exercise. This permits users to compare their intuitions, plans, or guidance with the implications of the analysis. If the proposed exercise is one of the optimal ones, then there is little basis for changing one's plans. If, however, the proposed exercise falls below the set of optimal exercises, then a careful examination of the reasons for the shortfall can be conducted. TRACES helps the user perform this examination by displaying two optimal exercises, one that provides the same amount of benefit (i.e., readiness return) for less cost and one that provides more benefit for the same cost.

Figure 4-7 shows the set of options available to the user in ANALYZE PROPOSED EXERCISE. Each is now considered in turn.

4.3.1.1 <u>Select exercise</u> - TRACES helps users specify a proposed exercise by prompting them through a set of choices. First, it requires that users select a major option (from the set analyzed in solve). Then, it systematically requests a deployment configuration for each of the agencies comprising the exercise. (In the event that the user fails to either select or complete this suboption, TRACES will assume any previous proposal still applies.) When this is completed, TRACES displays the composition of the proposed exercise (i.e., the major option and agency deployment configurations), and its cost and benefit.

4.3.1.2 <u>Display cost/benefit curve</u> - The primary graphical representation of the benefit-cost analysis is the efficient curve, which depicts the set of optimal (i.e., best) exercises for increasing costs. Selection of this option

50

```
             PROPOSED EXERCISE MENU

      1) SELECT EXERCISE
      2) DISPLAY COST/BENEFIT CURVE
      3) PRINT COST/BENEFIT CURVE
      4) DISPLAY POINTS MADE UP MATRIX
      5) DISPLAY OVERALL 'BENEFIT' MATRIX
      6) PRINT POINTS MADE UP MATRIX
      7) PRINT OVERALL 'BENEFIT' MATRIX
      8) DISPLAY AGENCY SORT W/O AG WT
      9) DISPLAY AGENCY SORT WITH AG WT
     10) PRINT SORTS
```

Figure 4-7

**SET OF OPTIONS AVAILABLE IN
"ANALYZE PROPOSED EXERCISE"**

displays that curve. The set of optimal exercises is indicated
by asterisks, the proposed exercise by a P; an exercise that is
cheaper than the proposed, but just as beneficial, by a C; and
a better exercise that costs the same as the proposed, by a B.
Since the primary value of comparing the proposed exercise to
the optimal exercises is derived from a detailed comparison of
the cheaper and better exercises, this capability is also pro-
vided; TRACES displays the major option and deployment configu-
ration for the proposed (P), cheaper (C) and better (B) exercises.

4.3.1.3 Print cost/benefit curve - This option
prints the efficient curve, and the major option and deployment
configuration for the proposed, cheaper, and better exercises.
Figure 4-8 illustrates this option for an integrated field
agency with a MAF, and the following proposed deployment config-
uration: a deployed TACC, a deployed TAOC, a full DASC, one
LAAM battery without missiles, one ASRT with no ordinance, and
one FAAD platoon with no ordinance. The following conditions
were set for this illustration: all the MCCRES scores were set
to 50; the agency weights were equal; th MPS weights within
each agency were equal; there were no fixed costs; the opera-
tional costs were those shown in Table 3-2; and the PDMUs were
those shown in page A-3 of Appendix A.

Under these conditions, as shown in Figure 4-8,
TRACES identified (1) an exercise that had the same benefit,
but was approximately $120,000 cheaper to conduct than the
proposed exercise, and (2) an exercise that provided a greater
training benefit (i.e., readiness return) for, in this case,
$50,000 less than the proposed exercise. Examination of
Figure 4-8 shows how the deployment configurations differ for
the proposed, cheaper, and better exercises.

BENEFIT-COST CURVE
(WITH PROPOSED, CHEAPER AND BETTER COMPOSITIONS)
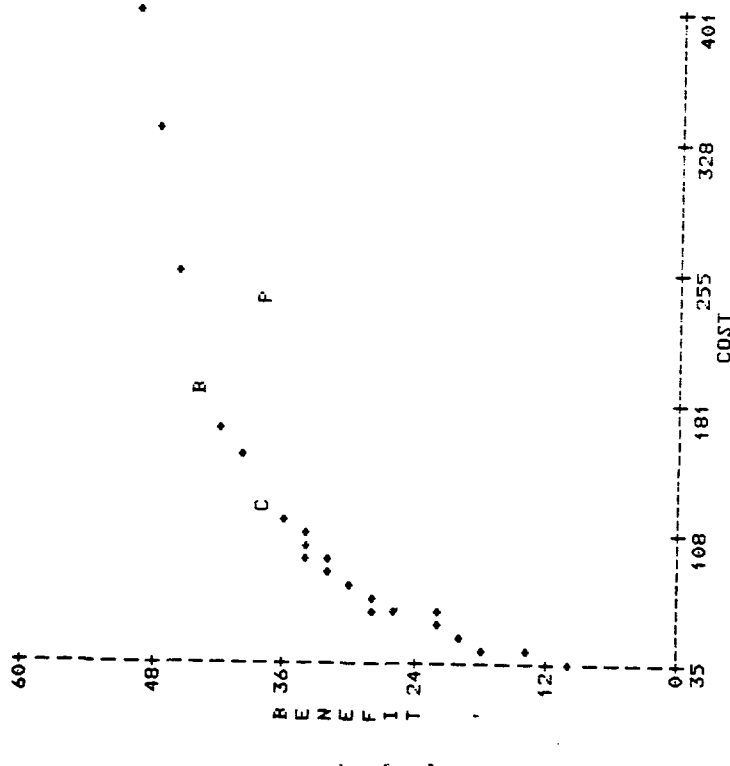
PROPOSED EXERCISE
FX; WITH MAF;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	DEPLOY
TADC	DEPLOY
DASC	FULL DASC
LAAM	1 (NO MI)
ASRT	1 (NO ORD)
FAAD	1 PL(-ORD)

COST	BENEFIT
241	38

CHEAPER EXERCISE
FX; WITH MAF;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TADC	NONDEPLOY
DASC	FULL DASC
LAAM	1 (NO MI)
ASRT	1 (WI ORD)
FAAD	2 PL(-ORD)

COST	BENEFIT
122	38

BETTER EXERCISE
FX; WITH MAF;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TADC	NONDEPLOY
DASC	FULL+MINI
LAAM	1 (NO MI)
ASRT	3 (WI ORD)
FAAD	2 PL(+DUM)

COST	BENEFIT
191	43

Figure 4-8

THE "PRINT COST/BENEFIT CURVE" OPTION IN THE "PROPOSED EXERCISE MENU"

It should be noted here that the cheaper and better exercises are located by the following simple rules. The cheaper exercise is the first exercise on the efficient curve that does not provide more benefit than the proposed exercise. The better exercise is the first exercise on the efficient curve that does not cost more than the proposed exercise.

4.3.1.4 Display points made up matrix - This option displays the expected number of points that will be made up for each agency by the proposed exercise. For example, assume that all six MACCS agencies received a score of 50 in their last MCCRES evaluation; consequently, there are 50 potential points to be made up for each agency. Assume that the users select a proposed package that will make up all of the deficit for the TACC, TAOC, and DASC, but none of the deficit for the LAAM, ASRT or FAAD. In this case, the points made up matrix would indicate that the proposed exercise will make up 50 points each for the TACC, TAOC and DASC, but 0 points for the LAAM, ASRT, and FAAD.

This option also displays the percentage of the deficit that will be made up for each agency by the proposed exercise. In our example above, the proposed exercise will make up 100 percent of the deficit for the TACC, TAOC, and DASC, but 0 percent of the deficit for the LAAM, ASRT, and FAAD.

4.3.1.5 Display overall benefit matrix - This option displays the expected readiness return of the proposed exercise for each agency. The readiness return value for each agency is calculated by multiplying the points made up by the agency weight. The sum of the readiness return values for the six agencies indicates the expected number of points that

the MACCS should make up on its overall MCCRES evaluation if the proposed exercise is implemented. TRACES also identifies the percentage of the total deficit made up by the proposed exercise.

4.1.3.6 <u>Print points made up matrix</u> - This option prints the display described in Section 4.3.1.4. Figure 4-9 illustrates this capability for the proposed exercise illustrated in Figure 4-8.

4.3.1.7 <u>Print overall benefit matrix</u> - This option prints the display described in Section 4.1.3.5. Figure 4-10 illustrates this capability for the proposed exercise illustrated in Figure 4-8.

4.3.1.8 <u>Display agency sort without agency weights</u> - TRACES provides different types of sorting routines to help users examine aspects of the benefit-cost analysis. The "agency sort without agency weights" orders the MPSs for each agency according to the points made up by the proposed exercise.

To use this option, users first select the agency and then TRACES displays how many points the proposed exercise makes up. Figure 4-11 illustrates this option for the proposed exercise illustrated in Figure 4-8.

4.3.1.9 <u>Display agency sort with agency weights</u> - This option orders the MPSs for each agency according to the overall benefit (i.e., readiness return) provided by the proposed exercise. Remember, overall benefit is calculated by multiplying the points made up by the agency weight. Figure 4-12 illustrates this option for the proposed exercise illustrated in Figure 4-8.

POINTS MADE UP (WITHOUT AGENCY WEIGHTS)

```
MAJOR OPTION: FX; WITH MAF; BOTH AD+AS                  OPER
DEPLOYMENT            TACC  TAOC  DASC  LAAM  ASRT  FAAD   COST

TACC: DEPLOY         21.5   6.9  12.2   1.7    .0   1.2 | 75.0
TAOC: DEPLOY         17.2  21.2   5.7  15.0   2.5   2.5 | 80.0
DASC: FULL DASC       8.0   5.7  19.5    .0   5.8   8.3 | 40.0
LAAM: 1 (NO MI)       1.2   8.2   1.4  15.8    .0   2.3 | 20.0
ASRT: 1 (NO ORD)       .3    .7   2.9    .0  12.5    .0 | 20.0
FAAD: 1 PL(-ORD)       .9   2.0   2.3   3.3    .0  21.7 |  6.0

TOTALS               49.1  44.7  44.0  35.8  20.8  36.0  241.0
%DEFICIT MADE UP       98    89    88    72    42    72
```

Figure 4-9

THE "POINTS MADE UP MATRIX" IN THE
"PROPOSED EXERCISE MENU"

```
OVERALL 'BENEFIT' READINESS RETURN MATRIX (WITH AGENCY WEIGHTS)

MAJOR OPTION: FX; WITH MAF; BOTH AD+AS                         OPER
DEPLOYMENT              TACC   TAOC   DASC   LAAM   ASRT   FAAD    TOT   COST

TACC: DEPLOY            3.6    1.2    2.0     .3     .0     .2    7.2|  75.0
TAOC: DEPLOY            2.9    3.5     .9    2.5     .4     .4   10.7|  80.0
DASC: FULL DASC         1.3    1.0    3.2     .0    1.0    1.4    7.9|  40.0
LAAM: 1 (NO MI)          .2    1.4     .2    2.6     .0     .4    4.8|  20.0
ASRT: 1 (NO ORD)         .0     .1     .5     .0    2.1     .0    2.7|  20.0
FAAD: 1 FL(-ORD)         .1     .3     .4     .6     .0    3.6    5.0|   6.0

TOTALS                  8.2    7.5    7.3    6.0    3.5    6.0   38.4 241.0
%DEFICIT MADE UP         98     89     88     72     42     72     77
```

Figure 4-10

THE "OVERALL BENEFIT MATRIX" IN THE
"PROPOSED EXERCISE MENU"

```
                              SELECT AN AGENCY

                                   1) TACC
                                   2) TAOC
                                   3) DASC
                                   4) LAAM
                                   5) ASRT
                                   6) FAAD
          PLEASE SELECT THE NUMBER OF THE DESIRED AGENCY: 1




          AGENCY: TACC

          MPS            DEFICIT MADE UP
          ---            ---------------

          MNU A/C           10.00
          EXT AO            10.00
          SUC OF C+C        10.00
          PHASE CNTL         9.80
          DSPLY              9.30
          PRESS EXECUTE TO CONTINUE.
```

Figure 4-11

**DISPLAY OF THE "AGENCY SORT WITHOUT AGENCY WEIGHTS"
OPTION IN THE "PROPOSED EXERCISE MENU"**

```
                         SELECT AN AGENCY

                              1)  TACC
                              2)  TAOC
                              3)  DASC
                              4)  LAAM
                              5)  ASRT
                              6)  FAAD
         PLEASE SELECT THE NUMBER OF THE DESIRED AGENCY. 1


         AGENCY: TACC

         MPS              DEFICIT MADE UP
         ___              _____

         MNG A/C              1.67
         EXT AG               1.67
         SUC OF C+C           1.67
         PHASE CNTL           1.63
         DSPLY                1.55
         PRESS EXECUTE TO CONTINUE.
```

Figure 4-12

DISPLAY OF THE "AGENCY SORT WITH AGENCY WEIGHTS"
OPTION IN THE PROPOSED EXERCISE MENU

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4.3.1.10 _Print sorts_ - This option lets users print four kinds of sorts. The first kind orders the MPSs for each agency according to the number of points made up by the proposed exercise. This kind of sort is essentially the "DISPLAY AGENCY SORT WITHOUT AGENCY WEIGHTS" option described in Section 4.3.1.8, except now TRACES prints the sorts for all agencies at the same time. Figure 4-13 illustrates this option for the proposed exercise described in Section 4.3.1.3.

The second kind of sort orders the MPSs for each agency according to the overall benefit (i.e., readiness return) provided by the proposed exercise. This kind of sort is essentially the "DISPLAY AGENCY SORT WITH AGENCY WEIGHTS" option described in Section 4.3.1.9, except now TRACES prints the sorts for all agencies at the same time. Figure 4-14 illustrates this option for the proposed exercise described in Section 4.3.1.3.

The third kind of sort orders the MPSs in one long list according to the overall benefit provided by the proposed exercise. This sort has the same information as the second sort, but the information is displayed differently. Figure 4-15 illustrates the option.

The fourth kind of sort orders the MPSs in one long list according to their potential benefit to the MACCS overall. Figure 4-16 illustrates this capability for the conditions specified in Section 4.3.1.3. As can be seen, the MPSs for the LAAM, ASRT, and FAAD have the greatest potential benefit in the example. Comparison with the sort in Figure 4-12 shows whether the proposed exercise is actually focusing on the MPSs with the greatest potential benefit.

MPS'S SORTED WITH AGENCIES
ACCORDING TO POINTS MADE UP
(DOES NOT INCLUDE AGENCY WEIGHTS)

COMPOSITION
FX: WIP MAF:
BOTH MEAS

AGENCY	DEPLOYMENT
TACC	DEPLOY
TAOC	DEPLOY
DASC	FULL DASC
LAAM	1 (NO MI)
ASRT	1 (NO ORD)
FAAD	1 PL(-ORD)

COST BENEFIT
241   38

AGENCY: TACC

MPS	DEFICIT MADE UP
MNG A/C	10.00
EXT AG	10.00
SUC OF C+C	10.00
PHASE CNTL	9.80
DSPLY	9.30

AGENCY: DASC

MPS	DEFICIT MADE UP
AIR DEFENS	9.10
PRE-PLAN	8.90
PHASE CNTL	8.80
REPORTS	8.70
IMMEDIATE	8.50

AGENCY: ASRT

MPS	DEFICIT MADE UP
BOMB CNTL	10.00
OPS PREP	8.33
POSITION	2.50

AGENCY: TAOC

MPS	DEFICIT MADE UP
ALT TACC	7.92
AIRSP MGMT	7.67
ENGAGE CTL	7.50
EMIS CNTL	7.50
PHASE CTNL	7.42
RADAR SURV	6.75

AGENCY: LAAM

MPS	DEFICIT MADE UP
SETUP	12.50
ENGAGE	11.67
ECM	11.67

AGENCY: FAAD

MPS	DEFICIT MADE UP
PHASE CNTL	13.33
ENGAGE	11.83
SUPPORT	10.83

Figure 4-13

"PRINT AGENCY SORT WITHOUT AGENCY WEIGHTS" OPTION IN "PROPOSED EXERCISE MENU"

MPS'S SORTED WITHIN AGENCIES
ACCORDING TO 'BENEFIT' READINESS RETURN
(INCLUDES AGENCY WEIGHTS)

```
COMPOSITION
FX; WITH MAF;
BOTH AD+AS

AGENCY    DEPLOYMENT
TACC      DEPLOY
TAOC      DEPLOY
DASC      FULL DASC
LAAM      1 (NO MI)
ASRT      1 (NO ORD)
FAAD      1 PL(-ORD)

COST   BENEFIT
241    38
```

AGENCY: TACC

MPS	DEFICIT MADE UP
MNG A/C	1.67
EXI AG	1.67
SUC OF C+C	1.67
PHASE CNTL	1.63
DSPLY	1.55

AGENCY: TAOC

MPS	DEFICIT MADE UP
ALT TACC	1.32
AIRSP MGMT	1.28
ENGAGE CTL	1.25
EMIS CNTL	1.25
PHASE CTNL	1.24
RADAR SURV	1.13

AGENCY: DASC

MPS	DEFICIT MADE UP
AIR DEFENS	1.52
PRE-PLAN	1.48
PHASE CNTL	1.47
REPORTS	1.45
IMMEDIATE	1.42

AGENCY: LAAM

MPS	DEFICIT MADE UP
SETUP	2.08
ENGAGE	1.94
ECM	1.94

AGENCY: ASRT

MPS	DEFICIT MADE UP
BOMB CNTL	1.67
OPS PREP	1.39
POSITION	.42

AGENCY: FAAD

MPS	DEFICIT MADE UP
PHASE CNTL	2.22
ENGAGE	1.97
SUPPORT	1.81

Figure 4-14

"PRINT AGENCY SORT WITH AGENCY WEIGHTS" IN "PROPOSED EXERCISE MENU"

MPS'S ORDERED BY OVERALL
READINESS RETURN ("BENEFIT")
(INCLUDES AGENCY WEIGHTS)

COMPOSITION
FXX WITH MAF;
BOTH AREAS

AGENCY	DEPLOYMENT
TACC	DEPLOY
TADC	DEPLOY
DASC	FULL BASE
LAAM	1 (BD MT)
ASPT	1 (BD OPD)
FAAD	1 PLC-GRD)

COST BENEFIT
241   53

AGENCY:MPS	BENEFIT MADE UP
FAAD: PHASE CNTL.	2.22
LAAM: SLIPP	2.03
FAAD: EMGAGE	1.77
LAAM: EMGAGE	1.50
LAAM: FLM	1.74
FAAD: SUPPORT	1.31
TACC: MAN A/C	1.47
TACC: EXT AG	1.67
TACC: SUC OF C+C	1.57
ASRT: BOMB CNTL.	1.42
TACC: PHASE CNTL.	1.63
TACC: DEPLY	1.52
DASC: ATP DEFFOS	1.52
DASC: PRE-PLAN	1.68
DASC: PHASE CNTL.	1.47
DASC: REPORTS	1.65
DASC: IMMEDIATE	1.63
ASRT: OPS PREP	1.32
TADC: ALT TACC	1.22
TADC: AIRSP MGMT	1.28
TADC: EMGAGE CTL.	1.25
TADC: EMIS CNTL.	1.25
TADC: PHASE CTRL.	1.22
TADC: RADAR SURV	1.13
ASRT: POSITION	.92

Figure 4-15

"PRINT OVERALL MPS SORT" OPTION IN
"PROPOSED EXERCISE MENU"

MPS'S ORDERED BY POTENTIAL DEFICIT
TO BE MADE UP
(INCLUDES AGENCY WEIGHTS)

AGENCY:MPS	DEFICIT
FAAD: PHASE CNTL	2.78
FAAD: ENGAGE	2.78
FAAD: SUPPORT	2.78
LAAM: SETUP	2.78
LAAM: ENGAGE	2.78
LAAM: ECM	2.78
ASRT: OPS PREP	2.78
ASRT: BOMB CNTL	2.78
ASRT: POSITION	2.78
TACC: PHASE CNTL	1.67
TACC: DSPLY	1.67
TACC: MNG A/C	1.67
TACC: EXT AG	1.67
TACC: SUC OF C+C	1.67
DASC: PHASE CNTL	1.67
DASC: PRE-PLAN	1.67
DASC: IMMEDIATE	1.67
DASC: AIR DEFENS	1.67
DASC: REPORTS	1.67
TAOC: PHASE CTNL	1.39
TAOC: RADAR SURV	1.39
TAOC: ENGAGE CTL	1.39
TAOC: EMTS CNTL	1.39
TAOC: AIRSP MGMT	1.39
TAOC: ALT IACC	1.39

Figure 4-16

"PRINT POTENTIAL DEFICIT SORT" OPTION IN
"PROPOSED EXERCISE MENU"

64

4.3.2 <u>Analyze best exercise</u> - This major option in the ANALYZE workspace permits users to request specific exercises on the efficient frontier. That is, either the users can specify a cost and allow TRACES to select the optimal exercise that most nearly conforms to that cost, or they can specify a desired readiness-return and allow TRACES to select the optimal exercise that most nearly provides that return. In both cases, they are using TRACES to select the best exercises instead of first pro- posing one themselves.

Figure 4-17 shows the set of options available to the user in ANALYZE BEST EXERCISE. Each is now considered in turn.

4.3.2.1 <u>Select best exercise</u> - Users specify the exercise on the efficient curve that they want to examine by selecting this option. Users can select "best" exercises in either of two ways: they can request the best exercise for a given cost or the best exercise for a given overall benefit (i.e., readiness return). TRACES tells the user how to make these requests.

4.3.2.2 <u>Display composition</u> - This option shows users the "best exercise" they just selected under "SELECT BEST EXERCISE", i.e., Option 1. This display shows the major training option, agency deployment configurations, total costs, and over- all benefit.

4.3.2.3 <u>Print composition</u> - This option prints the display for the best exercise selected under "SELECT BEST EXERCISE", and shown under "DISPLAY COMPOSITION". Figure 4-18 illustrates this capability for the best exercise for $100,000 under the following conditions: all the MCCRES scores were set to 50; the agency weights were equal; the MPS weights within each agency were equal; there were no fixed costs; the operational

```
               BEST EXERCISE MENU

     1) SELECT BEST EXERCISE
     2) DISPLAY COMPOSITION
     3) PRINT COMPOSITION
     4) DISPLAY POINTS MADE UP MATRIX
     5) DISPLAY OVERALL 'BENEFIT' MATRIX
     6) PRINT POINTS MADE UP MATRIX
     7) PRINT OVERALL 'BENEFIT' MATRIX
     8) DISPLAY AGENCY SORT W/O AG WT
     9) DISPLAY AGENCY SORT WITH AG WT
    10) PRINT SORTS
```

Figure 4-17

SET OF OPTIONS AVAILABLE IN
"ANALYZE BEST EXERCISE"

66

```
BEST EXERCISE
FX; AIR ONLY;
 BOTH AD+AS

AGENCY      DEPLOYMENT
TACC        NONDEPLOY
TAOC        NONDEPLOY
DASC        MINI DASC
LAAM        1 (NO MI)
ASRT        1 (WI ORD)
FAAD        2 PL(-ORD)

 COST    BENEFIT
  97       34
```

Figure 4-18

"PRINT COMPOSITION" OPTION IN
"BEST EXERCISE MENU"

costs were those shown in Table 4-1 (these are notional and do not represent official Marine Corps cost figures); and the PDMUs were those shown in Appendix A.

4.3.2.4 Display points made up matrix - This option displays the expected number of points that will be made up for each agency by the selected best exercise.

4.3.2.5 Display overall benefit matrix - This option displays the expected readiness return of the selected best exercise for each agency. In addition, it displays the overall readiness return for the selected best exercise, which is the expected number of points that the MACCS should make up on its overall MCCRES evaluation.

4.3.2.6 Print points made up matrix - This option prints the display described in Section 4.3.2.4. Figure 4-19 illustrates this capability for the best exercise for $100,000 (Figure 4-18) and under the conditions specified in Section 4.3.2.3.

4.3.2.7 Print overall benefit matrix - This option prints the display described in Section 4.3.2.5. Figure 4-20 illustrates this capability for the best exercise for $100,000 (Figure 4-18) and under the conditions specified in Section 4.3.2.3.

4.3.2.8 Display agency sort without agency weights - This option orders the MPSs, for a selected agency, according to the points made up by the selected, best exercise.

AGENCY	DEPLOYMENT CONFIGURATION	OPERATIONAL COSTS
TACC	NON-DEPLOYED	$ 10,000
	DEPLOYED	$ 75,000
TAOC	NON-DEPLOYED	$ 15,000
	EARLY WARNING	$ 16,000
	DEPLOYED	$ 80,000
DASC	NON-DEPLOYED	$ 10,000
	MINI DASC	$ 15,000
	FULL DASC	$ 40,000
	FULL PLUS MINI	$ 55,000
LAAM	NONE	$ 0
	1 BTRY (NO MISSILES)	$ 20,000
	2 BTRY (NO MISSILES)	$ 80,000
	3 BTRY (NO MISSILES)	$100,000
	1 BTRY (WITH MISSILES)	$128,000
	2 BTRY (WITH MISSILES)	$296,000
	3 BTRY (WITH MISSILES)	$424,000
ASRT	NONE	$ 0
	1 ASRT (NO ORDINANCE)	$ 20,000
	1 ASRT (WITH ORDINANCE)	$ 25,000
	2 ASRT (NO ORDINANCE)	$ 40,000
	2 ASRT (WITH ORDINANCE)	$ 50,000
	3 ASRT (NO ORDINANCE)	$ 60,000
	3 ASRT (WITH ORDINANCE)	$ 75,000
FAAD	NONE	$ 0
	1 SECTION (NO ORDINANCE)	$ 2,000
	1 SECTION (DUMMY ORDINANCE)	$ 3,000
	1 PLATOON (NO ORDINANCE)	$ 6,000
	1 PLATOON (DUMMY ORDINANCE)	$ 8,000
	2 PLATOONS (NO ORDINANCE)	$ 12,000
	2 PLATOONS (DUMMY ORDINANCE)	$ 16,000
	1 PLATOON (WITH MISSILES)	$ 48,000
	2 PLATOONS (WITH MISSILES)	$ 96,000

TABLE 4-1

NATIONAL OPERATIONS COSTS

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POINTS MADE UP (WITHOUT AGENCY WEIGHTS)

```
MAJOR OPTION: FX; AIR ONLY; BOTH AD+AS                    OPER
DEPLOYMENT            TACC  TAOC  DASC  LAAM  ASRT  FAAD   COST

TACC: NONDEPLOY       15.5   6.3   8.7   1.7    .0   1.2 | 10.0
TAOC: NONDEPLOY       14.0  12.9   5.2  14.2   2.5   2.5 | 15.0
DASC: MINI DASC        7.3   5.6  12.3    .0   4.2   2.5 | 15.0
LAAM: 1 (NO MI)        1.2   8.2   1.4  15.8    .0   2.3 | 20.0
ASRT: 1 (WI ORD)        .3    .7   2.4    .0  19.2    .0 | 25.0
FAAD: 2 PL(-ORD)        .9   2.7   3.0   4.2    .0  22.5 | 12.0

TOTALS                39.2  36.3  33.0  35.8  25.8  31.0   97.0
%DEFICIT MADE UP        78    73    66    72    52    62
```

Figure 4-19

"PRINT POINTS MADE UP" OPTION IN
"BEST EXERCISE MENU"

```
OVERALL 'BENEFIT' READINESS RETURN MATRIX (WITH AGENCY WEIGHTS)

MAJOR OPTION: FX; AIR ONLY; BOTH AD+AS                         OPER
DEPLOYMENT            TACC  TAOC  DASC  LAAM  ASRT  FAAD   TOT  COST

TACC: NONDEPLOY        2.6   1.1   1.4    .3    .0    .2   5.6| 10.0
TAOC: NONDEPLOY        2.3   2.2    .9   2.4    .4    .4   8.5| 15.0
DASC: MINI DASC        1.2    .9   2.0    .0    .7    .4   5.3| 15.0
LAAM: 1 (NO MI)         .2   1.4    .2   2.6    .0    .4   4.8| 20.0
ASRT: 1 (WI ORD)        .0    .1    .4    .0   3.2    .0   3.8| 25.0
FAAD: 2 PL(-ORD)        .1    .4    .5    .7    .0   3.7   5.5| 12.0

TOTALS                 6.5   6.1   5.5   6.0   4.3   5.2  33.5  97.0
%DEFICIT MADE UP        78    73    66    72    52    62    67
```

Figure 4-20

"PRINT OVERALL 'BENEFIT' MATRIX"
OPTION IN "BEST EXERCISE MENU"

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4.3.2.9 <u>Display agency sort with agency weights</u> -
This option orders the MPSs, for a selected agency according to
the overall benefit (i.e., readiness return) provided to the
MACCS by the selected, best exercise.

4.3.2.10 <u>Print sorts</u> - This option lets users
print the four kinds of sorts described in Section 4.3.1.10,
but now for the selected, best exercise. The first sort orders
the MPSs for each agency according to the number of points made
up by the selected, best exercise. The second sort orders the
MPSs for each agency according to the overall benefit (i.e.,
readiness return) provided by the selected, best exercise. The
third sort orders the MPSs in long list according to the overall
benefit provided by the selected, best exercise. And the fourth
sorts orders the MPSs in one long list according to their poten-
tial benefit to the MACCS overall. Figures 4-21, 4-22, and 4-23
illustrate the first three sorts; Figure 4-16 illustrates the
fourth sort, which does not depend on the type of exercise. To
compare the differences between the best exercise at $100,000
and the proposed exercise, which costs $241,000 the reader
should compare Figures 4-21 with 4-15, 4-22 with 4-16, and 4-23
with 4-17, respectively, for each of the three sorts. Again,
these comparisons depend totally on the conditions described
in Section 4.3.2.3.

4.3.3 <u>Analyze set of best exercises</u> - This is the third,
and last major option in the ANALYZE workspace. It permits users
to display the cost-benefit (i.e., efficient) curve, to print
the cost-benefit curve, and to print all the individual exercises
on the cost-benefit curve. Figure 4-24 shows the three options
available to the user in ANALYZE SET OF BEST EXERCISES.

4.3.3.1 <u>Display the cost-benefit curve</u> - This
option displays the cost-benefit curve.

MPS'S SORTED WITH AGENCIES
ACCORDING TO POINTS MADE UP
(DOES NOT INCLUDE AGENCY WEIGHTS)

COMPOSITION
FX; AIR ONLY:
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	MINI DASC
LAAM	1 (NO MI)
ASRT	1 (WI ORD)
FAAD	2 PL(-ORD)

COST	BENEFIT
97	34

AGENCY: TACC

MPS	DEFICIT MADE UP
MNG A/C	9.50
DSPLY	9.30
SUC OF C+C	8.00
PHASE CNTL	6.40
EXT AG	6.00

AGENCY: DASC

MPS	DEFICIT MADE UP
AIR DEFENS	8.60
PRE-PLAN	6.70
PHASE CNTL	6.50
REPORTS	6.40
IMMEDIATE	4.80

AGENCY: ASRT

MPS	DEFICIT MADE UP
OPS PREP	9.17
ROMB CNTL	7.17
POSITION	7.50

AGENCY: TAOC

MPS	DEFICIT MADE UP
EMIS CNTL	7.33
AIRSP MGMT	7.17
ENGAGE CTL	6.67
ALT TACC	6.67
RADAR SURV	4.42
PHASE CTNL	4.08

AGENCY: LAAM

MPS	DEFICIT MADE UP
SETUP	13.33
ECM	11.67
ENGAGE	10.83

AGENCY: FAAD

MPS	DEFICIT MADE UP
PHASE CNTL	11.67
ENGAGE	10.67
SUPPORT	8.67

Figure 4-21

"PRINT AGENCY SORT WITHOUT AGENCY WEIGHT" OPTION IN "BEST EXERCISE MENU"

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MPS'S SORTED WITHIN AGENCIES
ACCORDING TO 'BENEFIT' READINESS RETURN
(INCLUDES AGENCY WEIGHTS)

```
COMPOSITION
FX: AIR ONLY:
BOTH AREAS

AGENCY    DEPLOYMENT
TACC      NONDEPLOY
TAOC      NONDEPLOY
IASC      MINI BASE
LAAM      1 (NO MI)
ASRT      1 (WT GRID)
FAAD      2 PL(-GRID)

COST   BENEFIT
97     34
```

AGENCY: TACC

MPS	DEFICIT MADE UP
MNG A/C	1.58
DSPLY	1.55
SUC OF C+C	1.33
PHASE CNTL	1.07
EXT AG	1.00

AGENCY: TAOC

MPS	DEFICIT MADE UP
EMIS CNTL	1.22
AIRSP MGMT	1.19
ENGAGE CTL	1.11
ALT TACC	1.11
RADAR SURV	.74
PHASE CTNL	.68

AGENCY: IASC

MPS	DEFICIT MADE UP
AIR DEFENS	1.43
PRE-PLAN	1.12
PHASE CNTL	1.08
REPORTS	1.07
IMMEDIATE	.80

AGENCY: LAAM

MPS	DEFICIT MADE UP
SETUP	2.22
ECM	1.94
ENGAGE	1.81

AGENCY: ASRT

MPS	DEFICIT MADE UP
UPS PREP	1.53
BOMB CNTL	1.53
POSITION	1.25

AGENCY: FAAD

MPS	DEFICIT MADE UP
PHASE CNTL	1.94
ENGAGE	1.78
SUPPORT	1.44

Figure 4-22

"PRINT AGENCY SORT WITH AGENCY WEIGHTS" OPTION IN "BEST EXERCISE MENU"

MPS'S ORDERED BY OVERALL
READINESS RETURN (`BENEFIT`)
(INCLUDES AGENCY WEIGHTS)

COMPOSITION
FX; AIR ONLY:
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TADC	NONDEPLOY
DASC	MINI BASC
LAAM	1 (NO MI)
ASRT	1 (WI ORD)
FAAD	2 PL(-ORD)

COST	BENEFIT
97	34

AGENCY:MPS	DEFICIT MADE UP
LAAM: SETUP	2.22
FAAD: PHASE CNTL	1.94
LAAM: ECM	1.81
LAAM: ENGAGE	1.78
FAAD: ENGAGE	1.58
TACC: HNG A/C	1.55
TACC: DSPLY	1.53
ASRT: OPS PREP	1.53
ASRT: BOMB CNTL	1.53
FAAD: SUPPORT	1.94
DASC: AIR DEFENS	1.43
TACC: SUC OF C+C	1.33
ASRT: POSITION	1.25
TADC: EMIS CNTL	1.22
TADC: ATRSP MGMT	1.19
DASC: PRE-PLAN	1.12
TADC: ENGAGE CTL	1.11
TADC: ALT TACC	1.11
DASC: PHASE CNTL	1.08
TACC: PHASE CNTL	1.07
DASC: REPORTS	1.07
TACC: EXT AG	1.00
DASC: IMMEDIATE	.80
TADC: RADAR SURV	.74
TACC: PHASE CTNL	.68

Figure 4-23
"PRINT OVERALL MPS SORT" OPTION IN
"BEST EXERCISE MENU"

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```
SET OF BEST EXERCISES MENU

1) DISPLAY COST/BENEFIT CURVE
2) PRINT COST/BENEFIT CURVE
3) PRINT COMPOSITION
```

Figure 4-24

SET OF OPTIONS AVAILABLE IN
"ANALYZE SET OF BEST EXERCISES"

4.3.3.2 <u>Print the cost-benefit curve</u> - This option prints the cost-benefit curve. Figure 4-25 shows the cost-benefit curve based on the conditions described in Section 4.3.1.3 (and 4.3.2.3), and used as an example throughout Section 4.0 of this report. Comparison with Figure 4-8 shows that the cost-benefit curve in Figure 4-25 is the same as that printed in the PROPOSED EXERCISE MENU, but without the symbols P, C, and B.

4.3.3.3 <u>Print composition</u> - This option prints each of training exercises on the efficient curve. This is illustrated in Figure 4-26 for the initial portion of the efficient curve, developed when the cost-benefit analysis was performed for all eleven major options in SOLVE under the conditions used throughout Section 4.0. The most inexpensive training exercise is displayed in the upper left-hand corner of Figure 4-26; it is identified as Exercise 1. The next exercise on the efficient curve is Exercise 2, and so forth through the first nine exercises on the curve; the other exercises are not shown in the report because of space considerations.
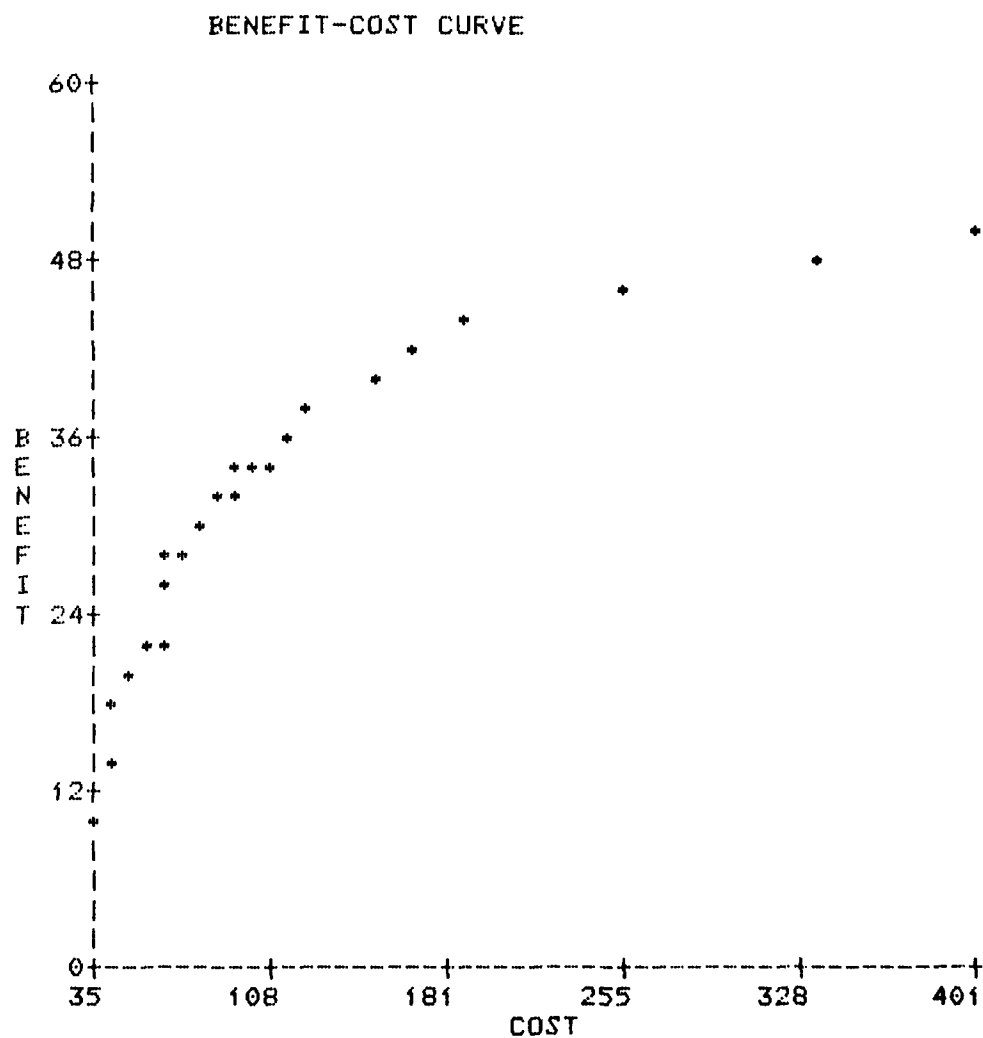
BENEFIT-COST CURVE

Figure 4-25

THE "PRINT COST/BENEFIT CURVE"
OPTION IN THE "SET OF BEST EXERCISES MENU"

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COMPOSITION OF EXERCISES ON THE BENEFIT-COST CURVE

EXERCISE 1
FX; AIR ONLY;
AIR DEFENSE ONLY

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	NONDEPLOY
LAAM	NONE
ASRT	NONE
FAAD	NONE

COST	BENEFIT
35	10

EXERCISE 2
CFX; AIR ONLY;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	NONDEPLOY
LAAM	NONE
ASRT	NONE
FAAD	NONE

COST	BENEFIT
35	10

EXERCISE 3
FX; WITH MAB,
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	MINI DASC
LAAM	NONE
ASRT	NONE
FAAD	NONE

COST	BENEFIT
40	14

EXERCISE 4
FX; AIR ONLY;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	MINI DASC
LAAM	NONE
ASRT	NONE
FAAD	NONE

COST	BENEFIT
40	15

EXERCISE 5
FX; WITH MAB;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	MINI DASC
LAAM	NONE
ASRT	NONE
FAAD	1 SC(-ORD)

COST	BENEFIT
42	18

EXERCISE 6
FX; WITH MAB;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	MINI DASC
LAAM	NONE
ASRT	NONE
FAAD	1 PL(-ORD)

COST	BENEFIT
46	20

EXERCISE 7
FX; WITH MAB,
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	MINI DASL
LAAM	NONE
ASRT	NONE
FAAD	1 PL(+DUM)

COST	BENEFIT
48	20

EXERCISE 8
FX; AIR ONLY;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	MINI DASC
LAAM	NONE
ASRT	NONE
FAAD	2 PL(+DUM)

COST	BENEFIT
56	21

EXERCISE 9
FX; AIR ONLY;
BOTH AD+AS

AGENCY	DEPLOYMENT
TACC	NONDEPLOY
TAOC	NONDEPLOY
DASC	MINI DASC
LAAM	1 (NO MI)
ASRT	NONE
FAAD	NONE

COST	BENEFIT
60	22

Figure 4-26

THE "PRINT COMPOSITION" OPTION IN THE "SET OF BEST EXERCISES" MENU

likely to be required. Thus, unless the Marine Corps' experience with either machine has been unduly negative, hardware maintenance seems likely to be comparable on any Marine Corps computer.

5.2 Software Maintenance

Most software is released in a form that requires additional attention. Sometimes, despite a vendor's best efforts to test the software prior to its release, "bugs" remain. Unless a dispute arises about the cause or realness of a bug, they are not of great concern since the vendor should be prepared to correct bugs, even following the software's release.

The important issue for software maintenance is the desire for system modifications following software release. Changes in the format of printouts or displays and new sorting or filing capabilities are examples of minor modifications that are frequently requested following software development. Support for such changes must either be provided internally by the customer or by a vendor.

Software maintenance takes on a new dimension for TRACES, because it is implemented in APL. APL is not an especially prevalent language and it cannot be assumed that Marine Corps personnel are proficient in its use. Thus, assuming that TRACES will remain in APL, the following options will be considered: (1) APL will be used without modification, (2) Marine Corps personnel will be trained in APL, or (3) a vendor will be hired to implement the modifications as needed.

If dependency upon a vendor for software maintenance is intolerable, then an alternative is to convert TRACES to COBOL or some other language with which Marine Corps personnel are

5.0 SYSTEM SUPPORT IMPLICATIONS

TRACES, like any other computer system, will require support if it is to be maintained and developed further. The exact nature of the future support requirements cannot be fully predicted, especially since it is uncertain how the Marine Corps will choose to use, maintain, and further improve TRACES. Nevertheless, certain broad implications can be drawn.

Before discussing TRACES support implications, three facts must be recognized.

1.   TRACES was implemented on an IBM 5110 computer.

2.   TRACES was be implemented in APL.

3.   TRACES is intended to be a headquarters tool used by the MCCRES team.

These facts form the basis for a discussion of two primary scenarios: one in which the Marine Corps uses TRACES as developed and another in which the Marine Corps converts TRACES to COBOL for operation on the IBM Series-1 computer.

5.1 Hardware Maintenance

At present, the MCCRES team at Marine Corps Headquarters has access to an IBM 5110 and could gain access to an IBM Series-1. Undoubtedly, the Marine Corps has considerable experience with the comparative reliability of these systems and would know best which hardware system requires the most support. In either case, a support arrangement with IBM is
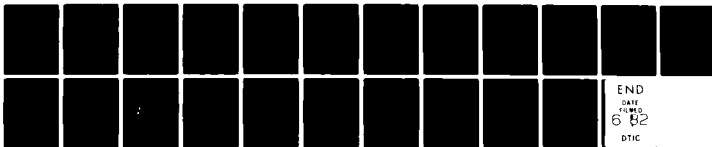
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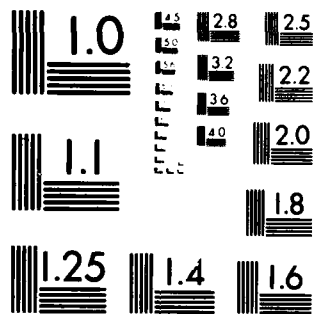
MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS 1963-A

more familiar. Such a conversion could be expensive and would, of course, require personnel who are familiar with both APL and COBOL.

The result is that the Marine Corps is confronted with two potentially costly alternatives: pay for a support contract from an outside vendor or pay for conversion to COBOL. The factors guiding this choice are:

1. The number of system modifications likely to be needed;

2. The extent of the Marine Corps' requirement for independence of outside firms; and

3. The lifetime of the MACCS TRACES.

In the event that the MACCS TRACES requires very few modifications or is likely to become outmoded by a new generation of TRACES, the use of outside support is appropriate. If, however, the MACCS TRACES is expected to remain in operation for many years, during which time numerous modifications would be required, then conversion to COBOL might be advantageous.

APPENDIX A
PERCENT DEFICIT MADE UP (PDMU)

APPENDIX A
PERCENT DEFICIT MADE UP (PDMU)

This Appendix lists the assessed values of the Percent Deficit
Made Up (PDMU) by each deployment configuration on each Mission
Performance Standard (MPS) and for each major training event. The
eleven major training events under consideration are:

    (1)   FX; with MAF; Both Air Support and Air Defense

    (2)   FX; with MAB; Both Air Support and Air Defense

    (3)   FX; with MAU; Both Air Support and Air Defense

    (4)   FX; Air Only; Both Air Support and Air Defense

    (5)   FX; with MAB; Air Support Only

    (6)   FX; with MAU; Air Support Only

    (7)   FX; Air Only; Air Support Only

    (8)   FX; Air Only; Air Defense Only

    (9)   CPX; with MAF; Both Air Support and Air Defense

    (10) CPX; with MAB; Both Air Support and Air Defense

    (11) CPX; Air Only; Both Air Support and Air Defense

Most of the MPS definitions are taken from MCCRES Volume VIII,
The Marine Air Command and Control System (MACCS) [MCO 3501.9;
OTOR/giv; 13 December 1979]. The three FAAD and three LAAM
MPSs are new.

PERCENT DEFICIT MADE-UP (PDMUS)
FOR MAJOR OPTION: FX, WITH MAF; BOTH AD+AS

		TACC					TAOC						DASC					LAAM			ASRT			FAAD		
		PHASE CNTL	DSPLY	MNG A/C	EXT A/G	SUC OF C+C	PHASE CTRL	RADAR SURV	ENGAGE CTL	EXIS CNTL	AIRSP MGT	ALT TAC	PHASE CNTL	PREPLAN	IMMEDIATE	AIR DEFENS	REPORTS	SETUP	ENGAGE	ECM	OPS PREP	RDR CNTL	POSITION	PHASE CNTL	ENGAGE	SUPPORT
TACC:	NONDEPLOY	20	25	55	20	35	10	3	6	17	20	20	10	30	25	10	30	0	5	5	0	0	0	5	2	0
	DEPLOY	50	25	55	40	45	12	3	6	17	20	25	15	35	32	10	30	0	5	5	0	0	0	5	2	0
TAOC:	NONDEPLOY	20	40	20	40	20	10	10	30	25	40	40	10	10	7	20	5	30	25	30	5	10	0	10	5	0
	EARLY WARN	10	20	10	10	20	35	30	35	27	25	30	10	10	7	10	5	15	10	15	5	10	0	5	2	0
	DEPLOY	22	40	20	60	30	50	40	40	30	45	50	15	10	7	20	5	30	30	30	5	10	0	10	5	0
DASC:	FULL DASC	20	20	25	0	15	11	7	3	13	20	15	40	40	40	40	35	0	0	0	15	20	0	15	10	25
	FULL+MINI	22	20	25	0	15	12	7	3	15	22	20	50	45	45	40	38	0	0	0	20	25	0	16	10	25
LAAM:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO MI)	2	5	0	0	5	10	25	30	25	3	5	3	0	0	10	1	40	25	30	0	0	0	5	9	0
	2 (NO MI)	2	8	0	0	5	13	35	35	27	3	5	3	0	0	12	1	50	30	45	0	0	0	7	11	0
	3 (NO MI)	2	10	0	0	5	16	40	40	30	3	5	3	0	0	14	1	60	35	60	0	0	0	9	13	0
ASRT:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO ORD)	2	1	0	0	0	1	1	1	2	3	0	5	3	5	0	15	0	0	0	30	30	15	0	0	0
	1 (WI ORD)	2	1	0	0	0	1	1	1	2	3	0	5	3	5	0	15	0	0	0	35	35	45	0	0	0
	2 (NO ORD)	2	2	0	0	0	2	2	1	2	6	0	5	6	10	0	20	0	0	0	45	50	26	0	0	0
	2 (WI ORD)	2	2	0	0	0	2	2	1	2	8	0	5	9	15	0	20	0	0	0	60	55	80	0	0	0
	3 (NO ORD)	2	3	0	0	0	3	3	1	2	8	0	5	9	15	0	25	0	0	0	50	60	32	0	0	0
	3 (WI ORD)	2	3	0	0	0	3	3	1	2	8	0	5	9	15	0	25	0	0	0	75	65	96	0	0	0
FAAD:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 FL(-ORD)	2	2	0	0	5	5	5	10	3	1	0	10	1	1	10	1	5	10	5	0	0	0	45	45	40
	1 FL(+DUM)	2	2	0	0	5	5	5	10	3	1	0	10	1	1	10	1	5	10	5	0	0	0	45	55	50
	2 FL(-ORD)	2	2	0	0	5	7	7	10	6	2	0	12	1	1	15	1	10	10	5	0	0	0	60	60	60
	2 FL(+DUM)	2	2	0	0	5	7	7	10	6	2	0	12	1	1	15	1	10	10	5	0	0	0	60	70	75

PERCENT DEFICIT MADE-UP (PDMUS)
FOR MAJOR OPTION: FX, WITH MAB, BOTH AD+AS

		TACC					TAOC						DASC					LAAM			ASRT			FAAD		
		PHASE CNTL	DSPLY	ENG A/C	EXT A/G	SUC OF C+C	PHASE CTNL	RADAR SURV	ENGAGE CTL	EMIS CNTL	AIRSP MGT	ALT TACC	PHASE CNTL	PRE-PLAN	IMMEDIATE	AIR DEFNS	REPORTS	SETUP	ENGAGE	ECM	OPS PREP	BOMB CNTL	POSITION	PHASE CNTL	ENGAGE	SUPPORT
TACC:	NONDEPLOY	20	22	40	20	35	10	3	6	17	15	20	10	25	20	10	25	0	3	5	0	0	0	4	2	0
	DEPLOY	50	22	40	40	45	12	3	6	17	15	25	15	30	25	10	25	0	3	5	0	0	0	4	2	0
TAOC:	NONDEPLOY	20	40	20	40	20	10	10	30	25	35	40	10	8	5	20	5	30	15	30	5	10	0	8	4	0
	EARLY WARN	10	20	10	10	20	35	30	35	27	20	30	35	8	5	10	5	15	5	15	5	10	0	4	1	0
	DEPLOY	22	40	20	60	30	50	40	40	30	40	50	50	8	5	20	5	30	20	30	5	10	0	8	4	0
DASC:	MINI DASC	20	20	23	0	15	11	5	3	13	18	15	25	25	22	30	27	0	0	0	15	15	0	8	6	15
	FULL DASC	20	20	23	0	15	11	5	3	13	20	15	35	33	28	30	27	0	0	0	15	20	0	10	8	17
	FULL+MINI	22	20	23	0	15	12	5	3	15	22	20	45	35	30	30	30	0	0	0	20	25	0	10	8	17
LAAM:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO MI)	2	5	0	0	5	1	25	30	25	3	5	3	0	0	10	1	40	20	30	0	0	0	4	8	0
	2 (NO MI)	2	8	0	0	5	1	35	35	27	3	5	3	0	0	12	1	50	25	45	0	0	0	6	10	0
	3 (NO MI)	2	10	0	0	0	1	40	40	30	3	5	3	0	0	14	1	60	30	60	0	0	0	8	12	0
ASRT:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO ORD)	2	1	0	0	0	1	1	1	2	3	0	5	3	5	1	15	0	0	0	30	30	15	0	0	0
	1 (WI ORD)	2	1	0	0	0	1	1	1	2	3	0	5	3	5	1	20	0	0	0	35	35	45	0	0	0
FAAD:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 SC(-ORD)	2	1	0	0	5	3	3	3	1	1	0	1	1	1	5	1	3	5	5	0	0	0	20	25	15
	1 SC(+DUM)	2	1	0	0	5	3	3	3	1	1	0	1	1	1	5	1	3	5	5	0	0	0	20	30	20
	1 PL(-ORD)	2	1	0	0	5	5	5	10	3	1	0	10	1	1	10	1	5	10	5	0	0	0	40	40	35
	1 PL(+DUM)	2	1	0	0	5	5	5	10	3	1	0	10	1	1	10	1	5	10	5	0	0	0	40	50	45

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	TACC					TAOC						DASC					LAAM			ASRT			FAAD		
	SUC OF C+C	EXT A/G	ENG A/C	DSPLY	PHASE CNTL	ALT TACC	AIRSP MGMT	EMIS CNTL	ENGAGE CTL	RADAR SURV	PHASE CTN	AIR REPORTS	AIR DEFENS	IMMEDIATE	PREPLAN	PHASE CNTL	TECH	ENGAGE	SETUP	POSITION	BOMB CNTL	OPS PREP	SUPPORT	ENGAGE	PHASE CNTL
TACC: NONDEPLOY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TAOC: EARLY WARN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DASC: FULL DASC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	c	0	0	0	0
LAAM: NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASRT: 1 (NO ORD)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FAAD: NONE	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
1 SC(-ORD)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 SC(+DUM)																									

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PERCENT DEFICIT MADE-UP (PDMUS)
FOR MAJOR OPTION: FX, AIR ONLY; BOTH AD+AS

		TACC					TAOC						DASC					LAAM			ASRT			FAAD		
		PHASE CNTL	DSPLY	MSG A/C	EXT AG	SUC OF C+C	PHASE CTN	RADAR SURV	ENGAGE CTL	EMIS CNTL	AIRSP MGMT	ALT TACC	PHASE CNTL	PRE-PLAN	IMMEDIATE	AIR DEFENS	RE PORTS	SETUP	ENGAGE	ECM	OPS PREP	BOMB CNTL	POSITION	PHASE CNTL	ENGAGE	SUPPORT
TACC:	NONDEPLOY	20	25	55	20	35	10	3	6	17	20	20	10	25	17	10	25	0	5	5	0	0	0	5	2	0
	DEPLOY	50	25	55	40	45	12	3	6	17	20	25	15	30	22	10	25	0	5	5	0	0	0	5	2	0
TAOC:	NONDEPLOY	20	40	20	40	20	10	10	30	25	40	40	10	10	7	20	5	30	25	30	5	10	0	10	5	0
	EARLY WARN	10	20	10	10	20	35	30	35	27	25	30	10	10	7	10	5	15	10	15	5	10	0	5	2	0
	DEPLOY	22	40	20	60	30	50	40	40	30	45	50	15	10	7	20	5	30	30	30	5	10	0	10	5	0
DASC:	MINI DASC	18	20	20	0	15	11	7	3	13	18	15	25	28	18	30	22	0	0	0	15	10	0	5	3	7
	FULL DASC	20	20	20	0	15	11	7	3	13	20	15	30	30	20	30	22	0	0	0	15	10	0	7	5	10
	FULL+MINI	22	20	20	0	15	12	7	3	15	22	20	35	35	22	30	25	0	0	0	20	15	0	7	5	10
LAAM:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO MI)	2	5	0	0	5	10	25	30	25	3	5	5	3	5	10	1	40	25	30	0	0	0	5	9	0
	2 (NO MI)	2	8	0	0	5	13	35	35	27	3	5	5	3	5	12	1	50	30	45	0	0	0	7	11	0
	3 (NO MI)	2	10	0	0	5	16	40	40	30	3	5	5	6	10	14	1	60	35	60	0	0	0	9	13	0
	1 (WI MI)	2	5	5	0	5	13	25	30	25	3	5	5	6	15	0	1	40	45	0	0	0	0	5	9	0
	2 (WI MI)	2	8	5	0	5	13	35	35	27	3	5	5	9	15	0	1	50	50	0	0	0	0	7	11	0
	3 (WI MI)	2	10	10	0	5	16	40	40	30	3	5	5	9	15	0	1	60	55	0	0	0	0	9	13	0
ASRT:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO ORD)	2	2	0	0	5	1	1	1	2	1	0	4	1	1	1	10	3	5	5	30	30	15	0	0	5
	1 (WI ORD)	2	2	0	0	5	1	1	1	2	1	0	6	1	1	1	10	3	5	5	35	35	45	0	0	10
	2 (NO ORD)	2	2	0	0	5	2	2	1	2	1	0	10	1	1	1	15	5	10	5	45	50	26	0	0	30
	2 (WI ORD)	2	3	0	0	5	2	2	1	2	1	0	10	1	1	1	15	5	10	5	60	55	80	0	0	40
	3 (NO ORD)	2	3	0	0	5	3	3	1	2	2	0	12	1	1	1	20	7	15	7	50	60	32	0	0	45
	3 (WI ORD)	2	2	0	0	5	3	3	1	2	2	0	12	1	1	1	20	7	15	7	75	65	96	0	0	45
FAAD:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 SC(-ORD)	2	2	0	0	5	3	3	3	1	1	0	4	3	3	5	1	3	5	5	0	0	0	15	20	5
	1 SC(+DUM)	2	2	0	0	5	3	3	3	3	1	0	6	3	3	5	1	3	5	5	0	0	0	15	25	10
	1 PL(-ORD)	2	2	0	0	5	5	5	10	3	2	0	10	6	10	10	1	5	10	5	0	0	0	35	45	30
	1 PL(+DUM)	2	2	0	0	5	5	5	10	3	2	0	10	9	15	10	1	5	10	5	0	0	0	35	55	40
	1 PL(MISS)	2	2	0	0	5	7	7	0	4	4	0	12	9	15	15	1	10	10	5	0	0	0	45	45	45
	2 PL(-ORD)	2	2	0	0	5	7	7	0	6	2	0	12	9	15	15	1	10	10	5	0	0	0	45	55	60
	2 PL(+DUM)	2	2	0	0	5	7	7	0	6	2	0	12	9	15	15	1	10	10	5	0	0	0	45	70	65
	2 PL(MISS)	2	2	0	0	5	7	7	0	6	2	0	12	9	15	15	1	10	10	5	0	0	0	45	70	65

PERCENT DEFICIT MADE-UP (PDMUS)
FOR MAJOR OPTION: FX, WITH MAB, AIR SUPPORT ONLY

		TACC					TADC						DASC					LAAM			ASRT			FAAD		
		PHASE CNTL	DSPLY	MNG A/C	EXT A/G	SUC OF C+C	PHASE CTNL	RADAR SURV	ENGAGE CTL	EMIS CNTL	AIRSP MGMT	ALT TACC	PHASE CNTL	PRE-PLAN	IMMEDIATE	AIR DEFENS	REPORTS	SETUP	ENGAGE	ECM	OPS PREP	BOMB CNTL	POSITION	PHASE CNTL	ENGAGE	SUPPORT
TACC:	NONDEPLOY	20	15	25	20	35	10	3	0	17	10	12	10	25	20	5	20	0	0	0	0	0	0	3	1	0
TADC:	NONDEPLOY	20	14	10	25	15	10	10	0	25	20	25	10	6	5	5	5	0	0	0	5	8	0	6	2	0
	EARLY WARN	10	12	5	5	15	35	30	0	27	10	20	10	6	5	5	5	0	0	0	5	8	0	3	1	0
DASC:	MINI DASC	20	20	23	0	20	11	7	0	13	18	20	25	28	28	20	27	0	0	0	15	20	0	6	3	8
	FULL DASC	20	20	23	0	20	11	7	0	13	20	20	30	35	30	20	27	0	0	0	15	25	0	8	4	10
LAAM:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASRT:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0
	1 (NO ORD)	2	1	0	0	0	1	1	0	2	3	0	5	3	5	1	15	0	0	0	30	30	15	0	0	0
FAAD:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 SC(-ORD)	2	1	0	0	5	3	3	0	1	1	0	3	1	1	5	1	0	0	0	0	0	0	15	12	12
	1 SC(+DUM)	2	1	0	0	5	3	3	0	1	1	0	3	1	1	5	1	0	0	0	0	0	0	15	15	17
	1 PL(-ORD)	2	1	0	0	5	5	5	0	1	1	0	10	1	1	10	1	0	0	0	0	0	0	30	20	25
	1 PL(+DUM)	2	1	0	0	5	5	5	0	1	1	0	10	1	1	10	1	0	0	0	0	0	0	30	25	35

PERCENT DEFICIT MADE-UP (PDMUS)
FOR MAJOR OPTION: FX, WITH MAU; AIR SUPPORT ONLY

		TACC				TAOC						DASC					LAAM			ASRT			FAAD		
		PHASE CNTL	DSPLY A/C	NXT A/G	SUC OF C+C	PHASE CTNL	RADAR SURV	ENGAGE CTL	EMISS CNTL	AIRSP MGMT	ALT TACC	PHASE CNTL	PREPLAN	IMMEDIATE	IMMED AIR DEFENS	AIR REPORTS	SETUP	ENGAGE	ECM	OPS PREP	BOMB CNTL	POSITION	PHASE CNTL	ENGAGE	SUPPORT
TACC:	NONDEPLOY	15	11	0	15	10	2	0	10	5	6	5	15	15	2	10	0	0	0	0	0	0	1	1	0
	DEPLOY	5	5	0	5	5	1	0	5	1	2	1	5	5	1	3	0	0	0	0	0	0	0	0	0
TAOC:	NONDEPLOY	15	15	5	15	10	5	0	15	10	10	5	3	3	2	1	0	0	0	0	0	0	1	1	0
DASC:	MINI DASC	15	15	15	15	11	5	0	5	9	10	10	20	20	10	15	0	0	0	0	0	0	4	2	6
LAAM:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASRT:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FAAD:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 SC(-ORD)	1	1	0	2	1	1	0	0	1	0	1	1	1	3	1	0	0	0	0	0	0	10	8	10
	1 SC(+DUM)	1	1	0	2	1	1	0	0	1	0	1	1	1	3	1	0	0	0	0	0	0	10	10	15

PERCENT DEFICIT MADE-UP (PDMUS)
FOR MAJOR OPTION: FX; AIR ONLY, AIR SUPPORT ONLY

Option	TACC PHASE CNTL	TACC DSPLY	TACC ENG A/C	TACC EXT AG	TACC SUC OF C+C	TAOC PHASE CNTL	TAOC RADAR SURV	TAOC ENGAGE CTL	TAOC EMIS CNTL	TAOC AIRSP MGMT	TAOC ALT TACC	DASC PHASE CNTL	DASC PRE-PLAN	DASC IMMEDIATE	DASC AIR DEFENS	DASC AIR REPORTS	LAAM SETUP	LAAM ENGAGE	LAAM ECM	ASRT OPS PREP	ASRT BOMB CNTL	ASRT POSITION	FAAD PHASE CNTL	FAAD ENGAGE	FAAD SUPPORT
TACC: NONDEPLOY	20	13	40	10	35	10	3	0	17	10	12	10	25	17	5	5	0	0	0	0	0	0	0	0	0
TACC: DEPLOY	40	13	40	20	45	12	3	0	17	10	15	15	30	22	5	20	0	0	0	0	0	0	0	0	0
TAOC: NONDEPLOY	20	20	10	25	15	10	10	0	25	25	30	10	6	5	5	5	0	0	0	5	5	0	0	0	0
TAOC: EARLY WARN	10	18	5	5	15	35	30	0	27	15	25	10	6	5	5	5	0	0	0	5	5	0	0	0	0
DASC: NONDEPLOY	15	20	23	0	20	11	7	0	13	18	20	2	30	20	20	22	0	0	0	15	10	0	0	0	0
DASC: MINI DASC	18	20	23	0	20	11	7	0	13	18	20	25	28	20	20	22	0	0	0	15	10	0	0	0	0
DASC: FULL DASC	20	20	23	0	20	11	7	0	13	20	20	30	30	22	20	22	0	0	0	15	10	0	0	0	0
LAAM: NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASRT: 1 (NO ORD)	2	1	0	0	0	1	1	0	2	3	0	5	3	5	1	10	0	0	0	30	30	15	0	0	0
ASRT: 1 (WI ORD)	2	1	0	0	0	1	1	0	2	3	0	5	3	5	1	10	0	0	0	35	35	45	0	0	0
ASRT: 2 (NO ORD)	2	2	0	0	0	1	2	0	2	6	0	5	6	10	2	15	0	0	0	45	50	26	0	0	0
ASRT: 2 (WI ORD)	2	2	0	0	0	1	2	0	2	6	0	5	6	10	2	15	0	0	0	60	55	80	0	0	0
ASRT: 3 (NO ORD)	2	3	0	0	0	1	3	0	2	8	0	5	9	15	3	20	0	0	0	50	60	32	0	0	0
ASRT: 3 (WI ORD)	2	3	0	0	0	1	3	0	2	8	0	5	9	15	3	20	0	0	0	75	65	96	0	0	0
FAAD: NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PERCENT DEFICIT MADE-UP (PDMUS)
FOR MAJOR OPTION: FX, AIR ONLY, AIR DEFENSE ONLY

	TACC PHASE CNTL	TACC DSPLY	TACC ENG A/C	TACC EXT A/G	TACC SUD OF C+C	TADC PHASE CTRL	TADC RADAR SURV	TADC ENGAGE CTRL	TADC EMIS CNTL	TADC AIRSP MGMT	TADC ALT TACC	DASC PHASE CNTL	DASC PREPLAN	DASC IMMEDIATE	DASC AIR DEFENS	DASC REPORTS	LAAM SETUP	LAAM ENGAGE	LAAM ECM	ASRT OPS PREP	ASRT BOMB CNTL	ASRT POSITION	FAAD PHASE CNTL	FAAD ENGAGE	FAAD SUPPORT
TACC: NONDEPLOY	20	20	45	20	35	10	3	6	17	15	15	5	0	0	2	7	0	5	5	0	0	0	5	2	0
TACC: DEPLOY	40	20	45	40	45	12	3	6	17	15	20	10	0	0	2	7	0	5	5	0	0	0	5	2	0
TADC: NONDEPLOY	20	40	20	40	20	10	10	30	25	35	35	5	0	0	3	5	30	25	30	0	0	0	10	5	0
TADC: EARLY WARN	10	20	10	10	20	35	30	35	27	20	25	5	0	0	2	5	15	10	15	0	0	0	5	2	0
TADC: DEPLOY	22	40	20	60	30	50	40	40	30	40	45	10	0	0	3	5	30	30	30	0	0	0	10	5	0
DASC: NONDEPLOY	15	10	15	0	10	11	7	3	13	5	10	2	0	0	10	10	0	0	0	0	0	0	3	2	5
DASC: MINI DASC	18	10	15	0	10	11	7	3	13	5	5	15	0	0	10	10	0	0	0	0	0	0	5	3	7
LAAM: NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAAM: 1 (NO MI)	2	5	0	0	5	10	25	30	25	3	5	3	0	0	5	1	40	25	30	0	0	0	5	9	0
LAAM: 2 (NO MI)	2	8	0	0	5	13	35	35	27	3	5	3	0	0	6	1	50	30	45	0	0	0	7	11	0
LAAM: 3 (NO MI)	2	10	0	0	5	16	40	40	30	3	5	3	0	0	7	1	60	35	60	0	0	0	9	13	0
LAAM: 1 (WI MI)	2	5	0	0	5	10	25	30	25	3	5	3	0	0	0	1	40	45	45	0	0	0	5	9	0
LAAM: 2 (WI MI)	2	8	0	0	5	13	35	35	27	3	5	3	0	0	0	1	50	50	50	0	0	0	7	11	0
LAAM: 3 (WI MI)	2	10	0	0	5	16	40	40	30	3	5	3	0	0	0	1	60	55	55	0	0	0	9	13	0
ASRT: NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FAAD: NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FAAD: 1 PL(-ORD)	2	2	0	0	5	5	5	10	3	1	0	5	0	0	0	2	5	10	5	0	0	0	35	27	30
FAAD: 1 PL(+DUM)	2	2	0	0	5	5	5	10	3	1	0	5	0	0	0	2	5	10	5	0	0	0	35	35	40
FAAD: 1 PL(MISS)	2	2	0	0	5	5	5	10	3	1	0	5	0	0	10	2	5	10	5	0	0	0	35	42	45
FAAD: 2 PL(-ORD)	2	2	0	0	5	7	7	10	6	2	0	6	0	0	0	2	10	10	5	0	0	0	45	35	45
FAAD: 2 PL(+DUM)	2	2	0	0	5	7	7	10	6	2	0	6	0	0	15	2	10	10	5	0	0	0	45	42	60
FAAD: 2 PL(MISS)	2	2	0	0	5	7	7	10	6	2	0	6	0	0	15	2	10	10	5	0	0	0	45	55	65

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PERCENT DEFICIT MADE-UP (PDMUS)
FOR MAJOR OPTION: CPX; WITH MAF; BOTH AD+AS

		TACC					TAOC						DASC					LAAM			ASRT			FAAD		
		PHASE CNTL	DSPLY A/C	MNG A/C	EXT A/G	SUC OF C+C	PHASE CTNL	RADAR SURV	ENGAGE CTL	EMIS CNTL	AIRSP MGMT	ALT TACC	PHASE CNTL	PRE-PLAN	IMMEDIATE	AIR DEFENS	REPORTS	SETUP	ENGAGE	ECM	OPS PREP	ROMB CNTL	POSITION	PHASE CNTL	ENGAGE	SUPPORT
TACC:	NONDEPLOY	20	25	25	20	35	10	3	3	10	10	20	10	10	7	5	18	0	2	2	0	0	0	0	0	0
	DEPLOY	40	25	25	40	45	0	3	3	10	10	25	15	13	9	5	18	0	2	2	0	0	0	0	0	0
TAOC:	NONDEPLOY	20	40	15	40	20	10	8	15	12	20	30	10	10	3	10	2	10	10	10	2	2	0	0	0	0
DASC:	MINI DASC	20	20	15	0	15	11	3	1	8	9	12	30	15	15	20	20	0	0	0	7	5	0	0	0	0
	FULL DASC	20	20	15	0	15	11	3	1	8	10	12	40	20	20	20	20	0	0	0	7	7	0	0	0	0
LAAM:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO MI)	1	2	0	0	5	10	0	15	10	1	5	2	0	0	2	1	5	5	8	0	0	0	0	0	0
	2 (NO MI)	1	2	0	0	5	13	0	20	12	1	5	2	0	0	3	1	10	10	12	0	0	0	0	0	0
	3 (NO MI)	1	2	0	0	5	16	0	25	15	1	5	2	0	0	4	1	15	15	16	0	0	0	0	0	0
ASRT:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO ORD)	1	1	0	0	0	1	0	1	2	1	0	5	2	5	1	10	0	0	0	5	5	0	0	0	0
FAAD:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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PERCENT DEFICIT MADE-UP (PDMUS)
FOR MAJOR OPTION: CPX, WITH MAB, BOTH AD+AS

		TACC						TAOC							DASC						LAAM				ASRT				FAAD		
		PHASE CNTL	DISPLAY	MNG A/C	EXT AGG	SUC OF C+C		PHASE CTNL	RADAR SURV	ENGAGE CTL	EMIS CNTL	AIRSP MGMT	ALT TACC		PHASE CNTL	PREPLAN	IMMEDIATE	AIR DEFENS	REPORTS	SETUP	ENGAGE	EXCH	OPS PREP	BOMB CNTL	POSITION	PHASE CNTL	ENGAGE	SUPPORT
TACC:	NONDEPLOY	20	22	20	20	35		10	3	3	10	7	20		10	8	5	5	16	0	1	2	0	0	0	0	0	0
	DEPLOY	40	22	20	40	45		0	3	3	10	7	25		15	9	7	5	16	0	1	2	0	0	0	0	0	0
TAOC:	NONDEPLOY	20	40	15	40	20		10	8	15	12	17	30		10	8	2	10	2	10	6	10	2	2	0	0	0	0
DASC:	MINI DASC	20	20	15	0	15		11	2	1	8	9	12		25	12	11	15	18	0	0	0	7	5	0	0	0	0
	FULL DASC	20	20	15	0	15		11	2	1	8	10	12		35	16	14	15	18	0	0	0	7	7	0	0	0	0
LAAM:	NONE	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	5	4	8	0	0	0	0	0	0
	1 (NO MI)	1	2	0	0	5		10	0	15	10	1	5		2	0	0	2	1	10	8	12	0	0	0	0	0	0
	2 (NO MI)	1	2	0	0	5		13	0	20	12	1	5		2	0	0	3	1	15	12	16	0	0	0	0	0	0
	3 (NO MI)	1	2	0	0	5		16	0	25	15	1	5		2	0	0	4	1				0	0	0	0	0	0
ASRT:	NONE	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO ORD)	1	1	0	0	0		1	0	1	2	1	0		5	2	5	1	10	0	0	0	5	5	5	0	0	0
FAAD:	NONE	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0

PERCENT DEFICIT MADE-UP (PDMUS)
FOR MAJOR OPTION: CPX; AIR ONLY; BOTH AD+AS

		TACC					TAOC						DASC					LAAM			ASRT			FAAD		
		PHASE CNTL	DISPLY A/C	MNG A/C	EXT A/G	SUC OF C+C	PHASE CTNL	RADAR SURV	ENGAGE CTL	EMHIS CTL	AIRSP MGT	ALT TACC	PHASE CNTL	PRE-PLAN	IMMEDIATE	AIR DEFENS	REPORTS	SETUP	ENGAGE	ECM	OPS PREP	BOMB CNTL	POSITION	PHASE CNTL	ENGAGE	SUPPORT
TACC:	NONDEPLOY	20	25	25	20	35	10	3	3	3	10	20	10	8	4	5	16	0	2	2	0	0	0	0	0	0
TAOC:	NONDEPLOY	20	40	15	40	20	10	8	15	12	20	30	10	10	3	10	2	10	10	10	2	2	0	0	0	0
DASC:	NONDEPLOY	15	20	15	0	15	11	3	1	8	9	12	10	10	9	15	14	0	0	0	7	4	0	0	0	0
	MINI DASC	18	20	15	0	15	11	3	1	8	9	12	20	10	9	15	14	0	0	0	7	4	0	0	0	0
LAAM:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1 (NO MI)	1	2	0	0	5	10	0	15	10	1	5	2	0	0	2	1	5	5	8	0	0	0	0	0	0
	2 (NO MI)	1	2	0	0	5	13	0	20	12	1	5	2	0	0	3	1	10	10	12	0	0	0	0	0	0
	3 (NO MI)	1	2	0	0	5	16	0	25	15	1	5	2	0	0	4	1	15	15	16	0	0	0	0	0	0
ASRT:	NONE	0	0	0	0	0	0	0	0	0	0	0	5	2	5	1	1	0	0	0	5	5	0	0	0	0
	1 (NO ORD)	1	1	0	0	0	1	0	1	2	1	0	5	2	5	1	5	0	0	0	5	5	0	0	0	0
FAAD:	NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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APPENDIX B

USING THE IBM 5110/20
PORTABLE COMPUTER

B-1

TRACES is implemented on the IBM 5110/20 portable computer (see Figure B-1). The following two sections describe how to start and stop the TRACES program. The third section describes the IBM 5110/20 equipment in some detail so that it can be used efficiently. Remember that there are no typewriter keys or switches that you can press that will damage the equipment. If you make a mistake, or an omission, there will always be the opportunity for corrections.

B.1 Starting the System

First, place three switches to the following positions: (1) the "L32 64 R32" switch to the center position (64); (2) the "BASIC/APL" switch to the BASIC position; and (3) the "DISPLAY REGISTERS/NORMAL" switch to the NORMAL POSITION. Then, turn on the IBM computer. If the printer is to be used for recording the output displays, make sure that it is connected prior to turning on the 5110. Do not connect or disconnect either the printer or the disk drives in the middle of any operation. To connect the printer and disk drive, screw the box-like appendage of the printer into the back of the disk drive, then screw the similar appendage of the disk drive into the back of the 5110. Be sure that all three units, the 5110, the printer, and the disk drive are plugged in.

You now have the computer on and all the equipment connected. When the computer has completed its internal check, the following display will appear in the lower left of the display screen:
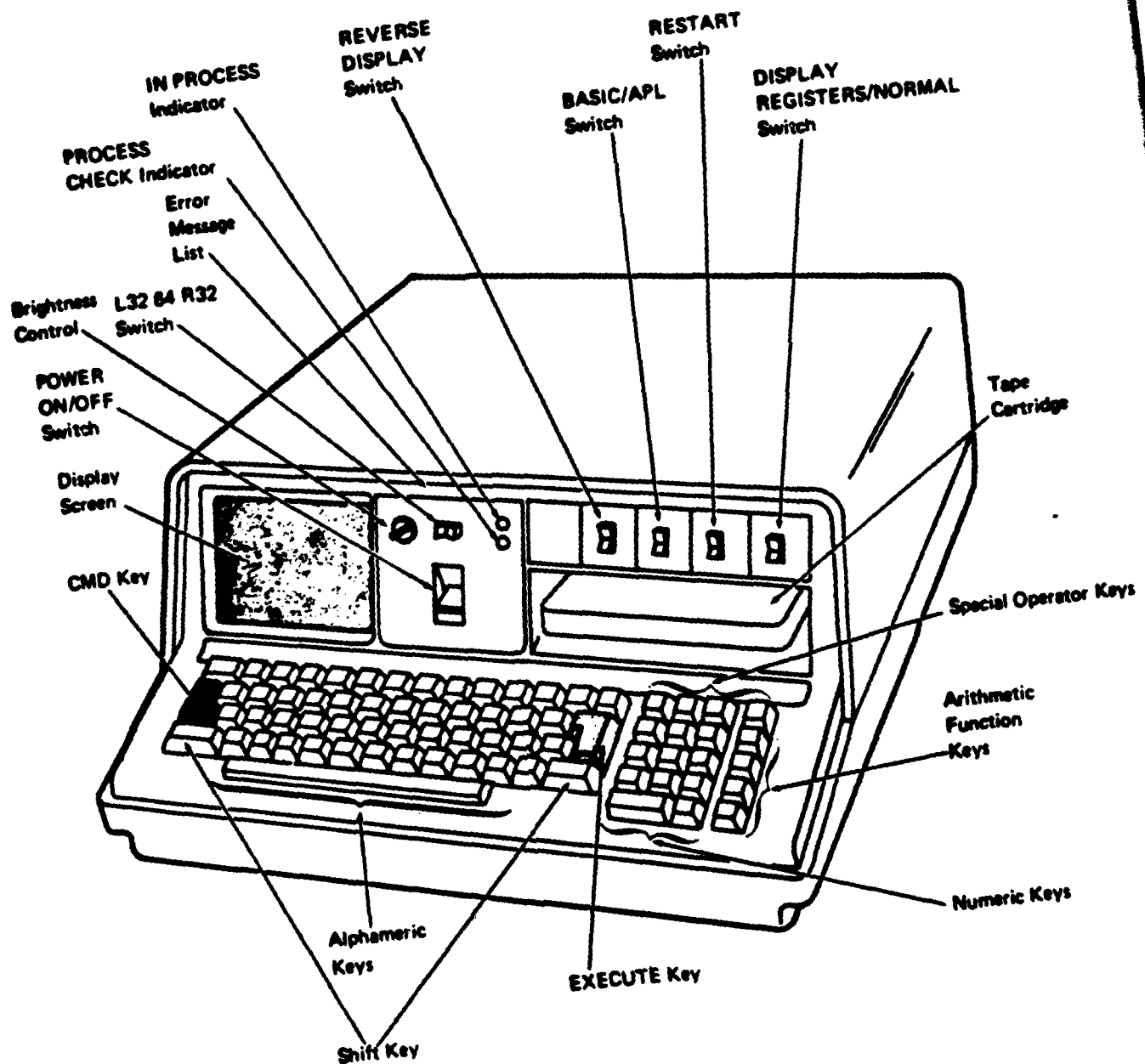
CLEAR WS

Figure B-1

CONSOLE OF THE IBM 5110 PORTABLE COMPUTER

B-3

Now, insert the TRACES diskette. This is done in one of two ways:
(1) for the 5110, the diskette is inserted in a vertical position
with the label on the right and away from the machine; (2) for
the 5120, the diskette is inserted in a vertical position with
the label to the left and toward the machine. After the diskette
has been inserted, type either of the following instructions:

```
)LOAD EDIT
    or
)LOAD SOLVE
    or
)LOAD ANALYZE
```

Press the EXECUTE key, and the computer will begin the desig-
nated part of the TRACES program. (See Section 4.0 for a detailed
discussion of the three work spaces.)

B.2 Bringing Down the System

When the user is finished with his work, he can bring down
the system by removing his diskette, turning the computer power
off, and turning the printer off. This can be done whenever the
computer is waiting for a user input but should not be done while
the printer or disk drive is operating. Do not turn off the
power before removing the diskette.

B.3 Equipment

B.3.1 Operator Selection Switches -

o   L32 63 R32 - This three-position switch allows the user
     to display the left 32 characters of the display (posi-
     tion L32), the right 32 characters (R32) or the entire
     display of 64 characters (64). Operation of the TRACES
     program requires that this switch be in the center
     position (64).

o   Reverse Display - Some users prefer viewing a black-
     on-white image to a white on black. The Reverse Dis-
     play switch allows the user to select the type of
     image he prefers. It should be noted that reversal
     of the display will require a brightness adjustment.
     The Reverse Display switch will not affect the
     image displayed on an auxiliary TV monitor.

o   BASIC/APL - The TRACES program is written in APL (A
     Programming Language), and this switch must be in the
     APL position. By placing the switch in the BASIC
     position, the computer is configured to operate in
     the BASIC language.

o   RESTART - The RESTART switch is used to re-initialize
     the IBM 5110/20. Depressing this switch is equivalent
     to turning off the power to the machine and restarting.

o   Display Registers/NORMAL - This switch should be in
     the NORMAL position when operating the TRACES program.
     The Display Registers position provides a display of
     internal machine code used in diagnostic testing of
     the machine.

B.3.2 The Display - The display is a cathode ray tube (CRT)
which allows 16 lines of data to be displayed. Each line may
contain up to 64 characters. The computer scrolls each line from
bottom to top. Lines that scroll off the top are lost. The dis-
play screen has two functions:

a)   As you type characters, these will appear on the bottom
     two lines of the screen. A flashing cursor (-) will
     indicate where the next character will be entered.

b)   The computer will help you organize and summarize the
     data that you enter. Tables of these data will be
     displayed on the upper 14 lines of the display.

When the 5110 is making computations, the screen will often go
blank, and the red (IN PROCESS) light will be illuminated.

B.3.3   <u>The Keyboard</u> - The layout of the IBM 5110 keyboard
is similar to that of a standard typewriter. As you will note,
many of the keys have special symbols embossed over the standard
typewriter characters. These symbols are used to write programs
in the APL language and are not necessary when operating the
TRACES program.

          In addition to the standard keyboard, note that the
5110 has a numeric keypad similar to an adding machine. These
keys are interchangeable with the numbers appearing in the top
row of the keyboard, and many users find them more convenient
to use.

          As characters are typed, they appear on the display
at the location identified by the cursor. In general, this will
occur on the bottom line of the display screen.

          Finally, there are a number of additional keys that
perform special functions. These keys are discussed below.

<u>SHIFT</u>

The SHIFT key performs the same function as a Shift key on
a typewriter.

FORWARD SPACE

When this key is pressed once, the cursor moves one posi-
tion to the right. When this key is held down, the cursor
continues to move to the right. When the cursor reaches
the last position on one input line, it goes to the first
position on the next input line.

BACKSPACE

When this key is pressed once, the cursor moves one posi-
tion to the left. When it is held down, the cursor contin-
ues to move to the left. When the cursor reaches position 1
on one input line, it goes to the last position on the pre-
vious input line.

HOLD

When pressed once, HOLD causes all processing to stop;
when pressed again, it allows processing to resume. The
primary purpose of HOLD is to permit reading the display
information during an output operation, when the display is
changing rapidly. When the hold is in effect (HOLD pressed
once), only the COPY DISPLAY key is active.

EXECUTE

When this key is pressed, the input line of information
on the display screen is processed by the system. This
key must be pressed for any input to be processed.

ATTN

The ATTN key erases from both the computer's memory and the display screen everything beyond the space where the flashing cursor is positioned. It does not erase anything before the flashing cursor.

INSERT

When the CMD key is held down and the forward space is pressed once, the characters at and to the right of the cursor position (flashing character) are moved to the right one position, and a blank character is inserted at the cursor position. The cursor does not move. For example:

                                          Flashing Character
    Before the insert operation: 123567
    After the insert operation: 123-567

When these keys are both held down, the characters continue to move to the right, and blank characters continue to be inserted.

DELETE

When the CMD key is held down and the backspace key is pressed once, the character at the cursor position (flashing character) is deleted, and all characters to the right are moved over one position to the left to close up the space. The cursor is not moved. For example:

Before the delete operation: 1234456
After the delete operation: 123456

When the keys are both held down, the characters at the cursor position continue to be deleted, and all the characters to the right are moved to the left.

B.3.4   <u>The Tape Cassette</u> - In many cases, this device is used to store the programs and data used by the 5110.   In the case of TRACES, however, the tape cassette is not used.   The disk drives are used instead.

B.3.5   <u>The Central Processor and Memory</u> - The central processor is a microprocessor developed by IBM.   This unit executes the commands stored in the computer's memory.

B.3.6   <u>The Printer</u> - The printer, when turned on, will print each line of the CRT screen exactly as it is displayed. It will be to your advantage to maintain printouts of many of the displayed tables.   Many of the tables are too long for the display, and the top portion will scroll off the display.   It is often easier to read these long tables from the printer rather than from the display screen.

The disadvantage of the printer is that it is significantly slower than the CRT display and will slow your progress. At different points in the exercise, the computer may suggest turning the printer on or off.   However, the operation of the printer is completely up to you.

If at any time the information on the display screen
seems important enough to record, a printed copy can be obtained
by turning on the printer then simultaneously pressing the CMD
button and the X button.

B.3.7 <u>The Disk Drives</u> - The disk drives are used to store
the programs and data used by TRACES. Before starting the pro-
gram, it must be loaded from a diskette. The computer automatic-
ally handles the control of the disk drives, but the user must
physically load the diskette into the machine.

B.3.8 <u>Potential Problems</u> - The TRACES program has many
internal safeguards which should prevent most problems, but
there are a few things that can go wrong.

<u>TYPING MISTAKE</u>

The first problem that is likely to occur is that a user
will mistype a response to the computer. This is very
easy to correct. Prior to depressing the EXECUTE key,
simply type over the portion of the response that is in-
correct, utilizing the Space Forward and Space Back keys.
Remember that the computer will not process a user res-
ponse until the EXECUTE key is depressed.

<u>PROCESS CHECK ERROR</u>

If the Process Check Light (Figure B-1) comes on, the
computer has encountered internal problems. Depress
RESTART and try again. If the light comes on again, an
IBM Service Representative should be notified.

DATE:

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